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1. MANAGEMENT

Gas Industry Expansion

Problems Beyond the Works Gates. T. C. Battersby. *Gas J. 303,* 198 (1960) Aug. 10 (6 pp.)

Expansion of gas usage depends, to some extent, on an experienced technical staff who constantly keep in touch with architects, builders and industrialists, says author. New loads mean a specialized sales force capable of exploiting the space-heating load. New developments must not overshadow the older houses where competitors have been making inroads.

Gas Industry Management

Market Research. A. Facer. *Gas World 152,* Aug. 6 (4 pp.)

Objective of article is to outline to management some of the techniques used in market research, to indicate the methods of sample selection, to show the method of tabulation of results and briefly to explain the calculations involved and the degree of accuracy obtainable. The final sections give the results of market research surveys carried out in the Pontypool undertaking.

Competition

Advance the Gas Flame and Your Business as Well. *Gas Heat and Comfort Cooling 11,* 40 (1960) Aug. (2 pp.)

Money for advertising and promotion—in large amounts—is the electric industry's strong point; and that point is now aimed at the heating business. One manufacturer of gas heating equipment believes that the electric people are attacking this market with no intention of turning over an electric heating business to him or anyone else. So he has organized a program for dealers and distributors who want to protect what they have from electrical contractors.

Gas Boom Is Oil's Bane, Winger Says. *Oil Gas J. 58,* 96 (1960) Sept. 5 (2 pp.)

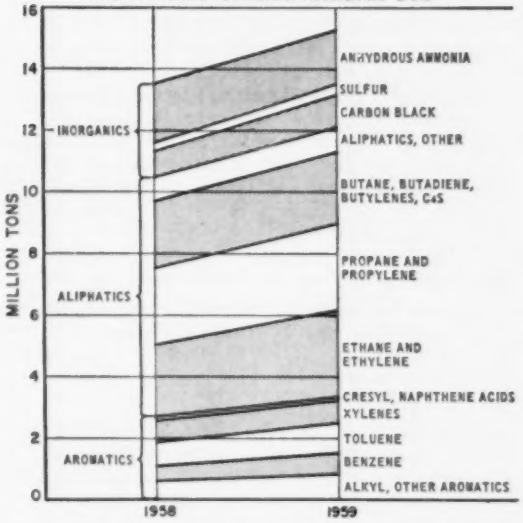
Expanded natural gas use has been a depressing factor in the oil industry, Chase Manhattan Bank economist, J. G. Winger, contends. At a recent American Bar Association meeting, he indicted natural gas as the culprit contributing heavily to many of the oil industry's problems. He thinks natural gas has helped shape market conditions which have brought about extremely low allowables in oil-producing states. Furthermore, he claims that oil has fed and fostered competition by not allocating proper costs to natural gas.

Corrosion

Management's Viewpoint. Value of Corrosion Protection on Pipe Line Systems. H. K. Phipps. *Corrosion 16,* 9 (1960) Aug. (2 pp.)

Principal reasons for adequate corrosion protection on pipelines are uninterrupted and efficient operation, preservation of good public relations, avoidance of damage claims from loss of life, fire or property damage, reduction of damage to equipment from corrosion

U.S. Production of Chemicals from Crude Oil and Natural Gas



(Adapted from *Petrochemicals: Their Volume Grows . . .* See Abstract, p. 198.)

products and full return from money invested in facilities. History of corrosion protection on pipelines is reviewed briefly and credit is given to the corrosion engineer for the substantial savings that have been effected through his efforts.

Cost Accounting

Cost Control in Relation to the Gas Engineer. B. Santo. *Gas World 152,* 226 (1960) Aug. 13 (8 pp.)

In the Cambridge Division the policy over many years has been to introduce modern methods of cost control; indeed, many original and unorthodox ideas in this field have been pioneered. As a result, the station engineer receives a flow of varied cost information at regular intervals which enables him to maintain close control of expenditures. The introduction of a cost control system does not in itself result in improved efficiency. It is a system of measurement and the results obtained must be promptly and correctly interpreted and effective action taken if the desired improvement in efficiency is to be achieved.

Ethylene

Ethylene Copes with Growing Competition. R. F. Messing and J. W. Bradley. *Chem. Eng. 67,* 66 (1960) Aug. 22 (6 pp.)

Ethylene, largest-volume aliphatic petrochemical raw material, is currently in reasonable demand-supply balance. Ethylene capacity, including that under construction, is approaching 5.8 billion lb/yr, which is 23% greater than estimated 1959 demand of 4.76 billion. Consumption in 1950 was 1.33 billion lb; average growth rate over the 1950-59 period has been 15.1%/yr.

Foreign Activities

Canada's Regulatory Profile. E. C. Manning. *Public Util. Fortnightly 66*, 217 (1960) Aug. 18 (11 pp.)

Regulatory bodies in Canada, far from being an impediment to a free enterprise economy, are vital in safeguarding the just rights of private, corporate and public interests. How regulation works within the Province of Alberta, and the rest of the Dominion, some of its problems, and an explanation of the function of the National Energy Board, created in 1959, are given by the author with special reference to the export of gas to the U.S.

Hydrogasification

Continuous Production of Natural Gas Supplements from Natural Gasoline and Petroleum Distillates in a Tube Furnace. W. G. Bair and H. R. Linden. *Institute of Gas Technology Research Bulletin No. 27.* (1960) June (83 pp.; $5.00).

Bulletin describes the pilot plant development of a continuous process for the gasification of natural gasoline, naphtha, kerosine and No. 1 fuel oil. Objective was to develop a low investment cost process capable of delivering a high heating value fuel gas directly substitutable for natural gas. Three methods were investigated, all comprising exposure of the vaporized feedstocks to temperatures of 1300°-1500°F, and moderate pressures not exceeding 100 psig: 1) thermal cracking in the absence of a carrier gas; 2) thermal cracking in the presence of hydrogen carrier gas supplied from an external source; and 3) thermal cracking with hydrogen carrier gas generated as part of the process. Detailed information on raw material requirements, product yields and compositions, and equipment design, is given for each method of operation.

Information

Gas Handbook Issue. *Am. Gas J. 187*, 17 (1960) Aug. 15 (entire issue.)

Annual edition of this handbook, directed toward the gas distribution field, includes articles on design, construction and materials; corrosion; regulation and measurement; odorization; properties of gases; peak shaving and LPG data; utilization; and general data such as conversion factors, and pressure and temperature conversion.

Petrochemicals

Big Surge in U.S. Petrochemical Building Projects May Be Last Pre-Maturity Fling. H. S. Pylant. *Oil Gas J. 58*, 112 (1960) Sept. 5 (4 pp.); **Petrochemical Plants in the United States.** *Ibid.*, 116 (13 pp.); **Petrochemical Plants Outside the U.S.** *Ibid.*, 129 (12 pp.)

Eighth annual survey of petrochemical plants and construction projects indicates that building is at an all-time high. And well over half of the newly announced U.S. projects are located on the Gulf Coast with major emphasis on polyolefins, synthetic rubber and styrene facilities. Although actual petrochemical production should approach 56.1 billion lb, the growth rate in 1960 is estimated to be only half of last year's 20.7%. Petrochemical production is expected to be 30.3% of total chemical production of 185.0 billion lb in 1960. Survey of U.S. plants, including headquarter addresses of all companies, indicates raw materials, capacities and products. Outside the U.S. new countries are being added as the worldwide petrochemical construction boom continues. Report is alphabetized by countries and by companies.

The Future of Chemicals from Petroleum. L. H. Williams. *Chem. & Ind.*, 1006 (1960) Aug. 6 (11 pp.)

Estimates of world energy requirements, with due allowance for the advent of nuclear power on the one hand and forward expectations as to the oil reserves position on the other, indicate quite clearly the long-term security of the future chemical industry based on oil. Good charts of products and applications are included.

Petrochemicals Face New Challenges. *Business Week 1618*, 50 (1960) Sept. 3 (15 pp.)

Thesis of special report is that the $3-billion petrochemical industry has to live with slower growth and a burst of competition from the oil industry. Divided into five parts, article discusses: why petrochemicals are appealing; the problems of growing too fast; how to keep expanding; petrochemicals with a future; and whether an industry crisis is inevitable. Those petrochemicals with a future are ethylene, propylene, butylene and acetylene.

Petrochemicals: Their Volume Grows, Their Applications Multiply. *Petrol. Week 11*, 40 (1960) Aug. 19 (10 pp.)

Market for petrochemicals is growing steadily, both in volume and in the variety of the demand. As a result, refiners' interest in that segment of their industry is rising, bigger more efficient plants are being built, stiff competition requires production of materials more closely tailored to customers' specific requirements. But the resulting multiplication of closely similar versions is proving to be a handicap to producers.

Pipeline Construction

Mexican Gas Line May Bring Vast Changes. *Oil Gas J. 58*, 96 (1960) Aug. 15 (2 pp.)

Proposed $200-million pipeline to import U.S. Gulf Coast and Mexican gas into California could have far-reaching effects on pipeline serving both the West and East Coasts. The gas industry throughout the U.S. will feel effects of competition for supplies. It also promises to have a big impact on gas development and prices.

Pipeline Operations

Newcomer Challenges Natural Gas Giant on West Coast. *Business Week 1620*, 50 (1960) Sept. 17 (5 pp.)

Transwestern Pipeline Co.'s new line from the Southwest to Southern California goes into operation at the end of September, giving El Paso Natural Gas its first rival for the lush California market. Already the new competition has affected prices and supply contracts. Article discusses this aspect of the pipeline operation.

Propylene

Propylene Sires Industry's New Hopefuls. R. F. Messing and J. W. Bradley. *Chem. Eng. 67,* 60 (1960) Sept. 5 (6 pp.)

Polypropylene is showing the most dramatic growth of the propylene derivatives and is currently attracting as much interest as any petrochemical—perhaps more, say authors. In addition to polypropylene, article discusses isoprene, isopropanol, perchloroethylene, propylene oxide, Oxo alcohols, short-chain-polymer use, synthetic glycerine and butylene.

Regulation

Can Regulators Be Judges? L. J. Hector. *Public Util. Fortnightly 66,* 289 (1960) Sept. 1 (8 pp.)

Several regulatory commissions, as well as utility industry leaders, may disagree, but author believes that regulation could well be handled by a department of the government responsible to the President, just as the Departments of Agriculture and Defense are handled. The highly complex or judicial aspects, he thinks, could be given to a special court to decide. Is it possible to separate successfully policy making and adjudication? Such a system has worked for federal tax cases with its division of duties between the Internal Revenue Service and the Tax Court. Problem is whether to extend this system to regulation.

Safety

Explosion of Dephlegmator at Cities Service Oil Company Refinery, Ponca City, Okla., 1959. M. G. Zabetakis. *U.S. Bur. Mines Rep. Invest. 5645,* 1960 (16 pp.)

Description of an investigation conducted by the Bureau regarding the cause of an explosion of a dephlegmator, or fractionating column, at Cities Service Oil Co. refinery on January 22, 1959. The explosion caused the death of an employee and resulted in extensive damage to the refinery and nearby property. The Bureau's study began on January 26.

Handling Cryogenic Fluids. R. M. Neary. *Quarterly Nat. Fire Protect. Assoc. 54.* 63 (1960) July (8 pp.)

Outline of safe procedures employed by one company in handling low-temperature fluids. Author discusses character of the fluids, storage facilities and liquid hydrogen. He maintains that understanding the properties of cryogenic liquids enables safe handling practice.

Six Safety Suggestions. H. E. Carroll. *Am. Gas J. 187,* 27 (1960) Aug. (2 pp.)

Stimulating interest in safety is a never-ending task, says author. He prescribes six ways to keep interest alive in a company: daily safety report, safety ads, safety jury, home safety, safety awards and safety publicity.

Space Heating

Gas Heating Service: A Business in Itself. *Gas Heat and Comfort Cooling 11,* 33 (1960) Aug. (3 pp.)

Article outlines the policy of a sales and installation business that makes most of its money on service work and, in addition, competes with "free" utility service.

2. ENERGY SUPPLY AND ECONOMICS

Coal

Research and Technologic Work on Coal and Related Investigations, 1958. *Bur. Mines Inf. Circ. 7970* (1960) 89 pp. (Washington: U.S. Govt. Printing Off., $.50.)

This report is the twenty-third in a series summarizing research and technologic work by the Federal Bureau of Mines on coal and related investigations; it is the fifth report to be issued on a calendar-year basis. Publications by Bureau personnel in 1958 are cited; in addition work in progress during the year is briefly described. The following areas are included in the report: origin and properties of coal, exploration and mining, gasification of coal, and complete conversion of coal to fluid fuels.

Energy Sources

Direct Conversion of Energy to Electricity. R. C. Ulmer and J. S. Sensenbaugh. *Combustion 32,* 30 (1960) Aug. (9 pp.)

Article presents general review of direct methods. Methods for special uses include piezoelectric generation, electric generators, solar energy converters, solid state devices, photochemical conversion, energy storage, nuclear energy converters and SNAP-III. Promising methods for large-scale power generation are fuel cells, thermionic converters, thermoelectric generators and magnetohydrodynamic generation.

Direct Energy Conversion. P. H. Egli. *J. Metals 12,* 615 (1960) Aug. (5 pp.)

Summary of US Naval Research Laboratory's work on direct conversion. This work is primarily directed toward utilization of nuclear energy. The same conversion processes, however, work equally well with other sources of energy, and for any particular application, all possible combinations of energy source and conversion processes should be examined, says author. Topics discussed are solar cells, thermoelectricity, thermionic emission and fuel cells.

Nuclear Energy's Growing Pains—Practical Problems Ahead. J. E. Gray. *Public Util. Fortnightly 66,* 306 (1960) Sept. 1 (9 pp.)

Some substantial research and development programs have been carried out in the field of nuclear energy. Much progress has been made in acquiring technical data and operating know-how. But much lies ahead before nuclear generation methods become of age. Such problems as economic life of equipment, nuclear fuel and other cost factors, disposal of radioactive wastes, safety standards, and which concepts of nuclear plants to concentrate on, all must be worked out. Finally, the question must be further resolved as to what role electric utilities should play in developing nuclear power.

Drilling

World Drilling. *World Oil 151,* 92 (1960) Aug. 15 (2 pp.)

Forecast indicates 5403 well completions outside the U.S. and Canada this year, up 360 wells or 7% over 1959. But U.S. completions are expected to decline to 46,324 in 1960 from 49,331 in 1959, a drop of 3007 wells or 6.1%. Canada also is expected to suffer a decrease in completions, to only 2620 from 2856, down 236 wells or 8.3%. Consequently only 54,347 completions are expected in the noncommunist nations. against 57,230 in 1959, a decline of 2883 wells or 5%.

Foreign Activities

India Invites Oil Capital. E. V. Corps. *Drilling and Producing 32,* B-59 (1960) Aug. (5 pp.)

To the west, north and east of the Indian Shield, which dominates the country geologically, and between it and the Himalayan range are the sediments of a large depositional gulf, occupying in general what are now the broad river valleys of the Indus, Ganges and Brahmaputra, and extending into the river system of the Meghna of East Bengal and the Irrawaddy of Burma. In a review of the oil prospects of India, it is estimated that there are about 400,000 sq miles of sedimentary basins in India where there are oil possibilities.

Pauley's Offshore Field May Make Mexico an Oil Explorer. *Petrol. Week 11,* 33 (1960) Sept. 2.

Under Pauley Pan American Petroleum Co.'s agreement with Pemex, the government company will take at least 25,000 bbl/day of Santa Ana crude, with the rest going to the world market. Pemex may take more if it wishes, however. Indicative of Pauley's hopes for the field is its order for a 12-well offshore drilling platform and plans to purchase additional platforms by early next year.

Hydrogen

Making the "Ultimate" Fuel. R. J. Nemmers. *Compressed Air 65,* 8 (1960) Aug. (5 pp.)

Variation of the crude oil separation and steam-carbon process is utilized to obtain hydrogen at the tonnage liquid-hydrogen-producing plant at Apix, Fla. This plant starts with crude oil and, by means of the Texaco partial oxidation process, derives a hydrogen stream made up not only of the approximately one-sixth (weight fraction) of the crude that is hydrogen, but also of the not inconsiderable quantity of the gas available from steam dissociation. Plant produces tonnage quantities of hydrogen at an annual rate of several millions of pounds, one estimate being 10,000,000 lb/yr.

Oil Shale

Constitution of Oil-Shale Kerogen: Bibliography and Notes on Bureau of Mines Research. W. E. Robinson and K. E. Stanfield. *Bur. Mines Inf. Circ. 7968* (1960) 79 pp. (Washington: U.S. Govt. Printing Off., $.45.)

Basic research on the structure of kerogen and processes by which it is degraded to useful products is needed to aid the development of new and better methods of using oil shale. At present government laboratories, education institutions, and private laboratories are studying these problems, but progress on this research is slow. Consequently, only a limited number of studies of this nature are described in the literature. The purpose of preparing these abstracts was to assemble the important data published through 1957 about the constitution of kerogen. Authors believe that these abstracts will help to correlate the available information and will be useful in future research on the constitution of kerogen.

Oil Yields of Sections of Green River Oil Shale in Colorado, 1954-57. K. E. Stanfield, J. W. Smith, H. N. Smith and W. A. Robb. *Bur. Mines Rep. Invest. 5614,* (1960) (186 pp.)

Congress in 1944 passed the Synthetic Liquid Fuels Act which authorized the Bureau of Mines to investigate sources of liquid fuels—coal, oil shale, natural gas, and agricultural products. The oil shale studies centered on the Green River formation in Colorado, Utah and Wyoming. Operation of a demonstration plant at Rifle, Colo., now in standby status, showed the feasibility of mining oil shale underground by a room-and-pillar method and processing the ore to liquid fuel. Basic laboratory research on oil shale and its products was conducted at the Laramie Petroleum Research Center in Laramie, Wyo., with accumulation of oil yield data for the Green River formation. This report is one of a series presenting the oil yields of sampled oil shale sections for use in appraising deposits as sources of liquid fuel. The reports are based on the assay to date of some 60,000 samples.

Petroleum

Petroleum, Mineral and Chemical Industries. E. Mattei, *Rivista dei Combustibili 14,* 451 (1960) June (12 pp. Italian text.)

After dealing with the problem of energy sources of the European Economic Community, author concentrates on the Italian situation, saying that his country will not accept any policy that would make the sources, which are now the most convenient, more expensive. In regard to Europe, he believes that a policy which keeps the energy price high, restrains consumption, locks up financial and human resources in unprofitable activities, and which prevents other resources from developing their more profitable income, could be a delaying element.

Prospects of the Oil Industry in Europe. H. Rastoul. *Rivista dei Combustibili 14,* 463 (1960) June (9 pp. Italian text.)

Article describes problems of exploring and producing raw products, and relates these problems to the present and future consumption of energy. Author believes that if production capacity is to double in the next decade, full-time exploration for new oil wells, both on the European and on the African continents, is necessary. Contribution which the French oil industry will be able to offer for the solution of these problems is considered.

World Demand and Supply. *World Oil 151,* 94 (1960) Aug. 15; **World Oil Reserves.** *Ibid.,* 95; **World Crude Oil Production.** *Ibid.,* 96 (2 pp.)

Article indicates that consumption of oil is rising about 1 million bbl/day each year. World demand rose 6.5% to 20,473,000 bbl/day in 1959. Similar gains are forecast for years ahead. Even so, world supply exceeded demand by 117,500 bbl/day in 1959. Oil reserves increased 11 billion bbl or 4.5% in 1959 to 256 billion. Output is forecast at 20,458,000 bbl/day in 1960. That would be 978,000 bbl/day or 5% above 1959 and above 20 million for the first time.

Sahara—1960. R. H. Touwaide. *Rev. Gen. du Gaz 82,* 141 (1960) July-Aug. (15 pp. French text.)

Author gives a complete account of the visit that he made to the Sahara earlier this year with a group from the Belgian gas industry. He describes in particular the oil field of Hassi Messaoud and the gas field of Hassi R'Mel. Added data by SNREPAL and COMES are included.

Fuel Cells

Significance of Fuel Cell Research to the Gas Industry. R. B. Rosenberg. *Rev. Gen. du Gaz 82,* 156 (1960) July-Aug. (11 pp. French text.)

For earlier abstract of this article, see *Gas Abstracts 15,* page 320.

Pipeline Construction

Gas Exports to Spur Future Canadian Growth. G. T. Kinney. *Oil Gas J. 58,* 114 (1960) Aug. 15 (4 pp.)

Proposed pipelines and the imminence of natural gas export combine to paint a picture of growth for the Canadian industry. More than 8 trillion CF of gas have been earmarked for export. The export projects of Trans-Canada Pipe Lines, Ltd., Alberta & Southern Gas Co. Ltd., Westcoast Transmission Co., Ltd., and Canadian-Montana Pipe Line Co. will result in an investment of $1 billion in pipeline, processing and related facilities. Economic importance of export is summarized in tabular form.

Gas Will Put Canadian Operations in the Black in 3 Years. C. O. Nickle. *Oil Gas J. 58,* 121 (1960) Aug. 15 (3 pp.)

Since Leduc, Canada has spent $4.77 billion, received $3.03 billion. Gas sales are expected to slash the annual deficit, and the first net gain is expected in 1963. But the cumulative deficit will not be erased until the 1970's. Provided the American authorities complete approvals in time, a $¾-billion crash program of pipeline construction, field gathering and gas processing plant construction will be initiated in September. By November 1961, the number of border-crossing points for Canadian gas will rise from two to seven, and in 1962, Canada's gas will be supplementing American supplies in U.S. markets by more than 400 billion CF/yr, for a border value exceeding $100 million.

Thermoelectricity

Refrigerating Apparatus Having Improved Heat Transferring Means. J. Roeder, Jr. (assigned to Whirlpool Corp.) U.S. 2,947,150 (1960) Aug. 2.

Improved thermoelectric refrigerating apparatus is claimed in which a thermocouple panel is formed of multiple metallic hot and cold junctions. These junctions are connected in series so that those that are hot are all disposed on one side of a foamed plastic insulating panel and those that are cold are on the other side. Each set of junctions is enclosed by heat exchanging chambers which are part of separate Freon refrigerant circulating systems. The cold junction chambers are connected to the coils for cooling the refrigerated space and the hot junction chambers are connected to a condenser for dissipating the heat and returning the Freon as liquid.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling

What We Know About Effect of Rotary Speed on Drilling Rate. P. L. Moore and C. Gatlin. *Oil Gas J. 58,* 170 (1960) Aug. 15.

Drilling rate increases with rotary speed at a decreasing rate as the speed is increased. However, a satisfactory theory has not been developed and the relationship is empirical. Effects of rotary speed do not stand out clearly and alone. They are interrelated with the effects of drilling fluid and bottom hole cleaning. On the other hand, contact time between bit tooth and rock varies inversely with rotary speed. It is not yet certain exactly how important this contact time is in the degree of rock damage.

Drilling Analysis Charts. O. E. Mechem. *Oil Gas J. 58,* 66 (1960) Aug. 22 (7 pp.)

This is one of the sharpest tools oil-company management has for reducing costs, says author. These charts induce good programing, the key to cutting drilling costs. Management can analyze thoroughly each operation, appraise contractor performance, spot factors which need improving, direct staff studies to improve well planning, and utilize latest research findings.

Exploration

Canadian Explorers Ponder New Province in Central British Columbia. H. P. Trettin. *Oil Gas J. 58,* 142 (1960) Aug. 15 (4 pp.)

Article first describes the general geology and geological history of the Fraser River area between Lillooet and Big Bar. Then it discusses the chances for oil and gas as well as the technical problems of exploration—first in the Fraser River area and then in Central British Columbia in general.

Jurassic Wildcatters Scoring Regularly. *Oil Gas J. 58,* 98 (1960) Aug. 15 (2 pp.)

Opening of two additional Jurassic fields (Texas) recently raises to six the number that have been found to date this year in the district. With nearly a half-year of exploration remaining, this is double the number discovered in any previous year. Only one was found in 1959. Latest of this year's new fields is on the eastern edge of the district bordering Louisiana.

Southeast Oklahoma Reawakens as Potential Gas Giant. C. B. Branan, Jr. and L. Jordan. *Oil Gas J. 58,* 120 (1960) Aug. 8 (3 pp.)

With increased demand for and value of natural gas reserves, the Arkoma basin and the Ouachita Mountains in southeastern Oklahoma have come to the forefront of exploration in that state in the 1959-60 period. Recently two geologically and economically significant tests drilled in Latimer County have resulted in natural gas production: one on the Brazil anticline in the McAlester sector of the Arkoma basin, and the other south of the Choctaw fault in the Potato Hills area of the Ouachita Mountains.

Spain Seeks Bigger Role in Petroleum. E. Recasens. *Pipeline Eng. 32,* E-1 (1960) Sept. (11 pp.)

Maps, tables and discussion are given on new Spanish law of concessions, and on exploration, geology, refineries, petrochemicals and distribution.

Third Step in Hunt for Oil Is Gulf Probe. *Oil Gas J. 58,* 220 (1960) Sept. 5.

Florida oil seekers are probing into the Gulf of Mexico in their continuing search for production in a province that has baffled drillers 281 out of 293 trys. California Co. has agreed to drill a 13,500-ft wildcat 4 miles seaward of La Costa island off Lee County. Florida's production is limited to the Everglades, 90 miles northwest of Miami, where 11 wells are producing 1000 bbl/day from Sunniland Glen Rose Lower Cretaceous lime below 11,000 ft.

Geology

Aquifer Behavior in Gas Production. D. L. Katz. *Oil and Gas Compact Bull. 19,* 14 (1960) June (7 pp.)

In connection with gas storage, geological and engineering studies have been conducted which enhance knowledge of the behavior of water underground strata. The creation of gas bubbles in water-bearing sands or aquifers as a means of storing natural gas in summer for use in winter has given new experiences on water movement. It thus becomes appropriate that the nature of water-bearing zones in the earth's crust be considered.

Logging

Applications of Nuclear Science in Petroleum Production. M. Williams. *J. Petrol. Tech. 12,* 11 (1960) Aug. (3 pp.)

Article reviews contributions of nuclear science to well logging and to geochronology, discusses use of radioactive tracers in well completion, well testing and repairs, and briefly mentions possible applications for utilizing energy released by nuclear explosions in petroleum production.

Field Examples of Nuclear Magnetism Logging. P. Hull and J. E. Coolidge. *J. Petrol. Tech. 12,* 14 (1960) Aug. (9 pp.)

Field examples from various operating areas are presented to demonstrate capability of the nuclear magnetism log to operate under most drilling and formation conditions. Operational factors are discussed, along with methods of interpretation of original data.

In Western Oklahoma, Sonic Log Evaluates Morrow Sand. F. S. Millard. *Drilling and Producing 32,* B-29 (1960) Aug. (6 pp.)

Empirical curves which relate weighted core porosity and formation velocity or transit time have been developed for the relatively shale-free Morrow sand in western Oklahoma. The effect of fluid and residual gas in the invaded zone has been investigated and is considered in the empirical curves. The comparison of formation resistivity and transit time using specially designed graph paper in many instances provides a rapid method of formation evaluation. Some examples showing the application, advantages and limitations of the procedure are presented.

Nuclear Magnetism Logging. R. J. S. Brown and B. W. Gamson. *J. Petrol. Tech. 12,* (Tech. Paper 8124) 201 (1960) Aug. (9 pp.)

Theory of new logging method is described, which is based on measurement of nuclear magnetism of formation fluids. Method operates well in oil- and water-base muds and empty holes, and can be used in all kinds of formations except strongly magnetic ones.

Reservoir Engineering

Correlation of Oil Formation Volume Factor and Solution Gas-Oil Ratio. C. R. Knopp and L. A. Ramsey. *J. Petrol. Tech. 12,* 27 (1960) Aug. (3 pp.)

Article correlates thermally-reduced oil formation volume factors with solution gas-oil ratio from 0 to 3500 CF/bbl, using differential liberation curves of 159 analyses of saturated Eastern Venezuelan crudes. Average error is found to be 2% by comparing correlation and calculated laboratory-determined oil formation volume factor.

Oil Recovery and Formation Damage in Permafrost, Umiat Field, Alaska. O. C. Baptist. *U.S. Bur. Mines Rep. Invest. 5462,* 1960 (22 pp.)

Core samples were tested in the laboratory to determine the physical properties, clay content and capillary behavior of the sands and their susceptibility to water damage. Larger core samples were tested under simulated permafrost conditions to determine the effect of freezing of interstitial water on oil recovery and the effect of gas-oil ratio on oil recovery when the oil is produced by solution gas expansion from low saturation pressures. Also determined were the effects of freezing of interstitial water on relative permeability to oil and on oil recoverable by gas drive after solution gas expansion. Major results and conclusions are discussed.

Performance Predictions for Low Productivity Reservoirs. R. D. Carter and G. W. Tracy. *J. Petrol. Tech. 12,* (Tech. Paper 8123) 195 (1960) Aug. (6 pp.)

Calculation on behavior of reservoirs with high-pressure drawdown and wide spacing, where initial productivity is low and wells are completed by hydraulic fracturing, is discussed. It is concluded that hydraulic fracturing increases recovery but results in higher producing GOR's early in producing history. It is found that two-phase flow calculations give less optimistic predictions of reservoir performance than conventional calculation methods.

Secondary Recovery

How Californians Operate their Water Floods. *Oil Gas J. 58,* 73 (1960) Aug. 22 (4 pp.)

West Coast operators were slow in accepting water flooding because of high gravity oil and thick producing sections. Now, however, a total of 84 reservoirs in 49 fields are being flooded. Floods range in size from 50-bbl to 401,000-bbl/day of water injection.

Process for Recovering Hydrocarbons from Underground Formations. M. R. Tek and A. F. Bertuzzi (assigned to Phillips Petroleum Co.) U.S. 2,946,382 (1960) July 26.

Improved recovery of hydrocarbons by *in situ* combustion is claimed by providing a central well and a pattern of several surrounding wells. The central well is perforated and fractured at several levels of the producing formation and the other wells are also fractured, but at different vertical intervals than in the past. Air is injected and heated in one of the pattern wells, causing a combustion zone which moves vertically between the two sets of fractures and thus drives the hydrocarbons to the central well.

4. GAS CONDITIONING AND LPG RECOVERY

Dehydration

How to Design Glycol Dehydrators for 100°F-Plus Dew-Point Depression. C. R. Perry. *Oil Gas J. 58,* 71 (1960) Aug. 8 (4 pp.)

Process design data for triethylene glycol dehydration of natural gas for dew-point depressions in the 60°-115°F range have been calculated and correlated and are presented in the article. Although the calculations represent theoretical performances, they have correlated very well with field test data. They were calculated from published equilibrium and vapor-pressure data. Column design, equilibrium curves, capacities and transfer calculations are discussed.

Dust Removal

Gas Cleaners: A Qualitative Analysis. N. W. Wiederhorn and A. W. Doyle. *Pipeline Eng. 32,* D-49 (1960) Sept. (5 pp.)

Many varieties of gas cleaners are used by the gas industry, with the oil bath scrubber the most prevalent type. Centrifugal or cyclone type cleaners also find considerable application, as do a large number of different types and designs of filters. Report discusses operating principles of each type of cleaner. Much of the data is based on results of research work performed on "Suspensoids in Natural Gas" for the A.G.A. as a PAR project and supervised by the Committee for Project NFX-12.

Hydrocarbon Recovery

Canadian Gas-Processing Plant Will Be Joint Effort of 26 Operators. *Oil Gas J. 58,* 160 (1960) Aug. 15 (2 pp.)

British-American Oil Co. Ltd. has joined with 25 other companies to build processing facilities between Homeglen-Rimbey and Dick Lake fields in Alberta. The plant will have a capacity of 325 MMCF/day of raw gas that will be gathered separately from the Leduc D-3 reservoir of each field. Residue gas will be delivered to Alberta Gas Trunk Line Co., Ltd., for the account of Trans-Canada Pipe Lines, Ltd., and Alberta and Southern Gas Co., Ltd.

Hydrocarbon Removal

Gas-Processing Plant Features. *Oil Gas J. 58,* 79 (1960) Aug. 29.

New $3,000,000 gas processing plant near Bridgeport, Texas, is designed for an initial capacity of 100 MMCF/day of natural gas with allowances for later expansion to 150 MMCF/day. Liquid production is expected to be more than 177,000 gal daily. Some of the relatively new features included in the plant design are direct thermal stripping, an absorption-oil presaturator unit, a fractionating-type lean-oil still, and a hydraulic-power recovery unit that uses pressure letdown of the rich oil stream from the absorbers to the flash tank.

Hydrogen Sulfide Removal

Apparatus for Converting Hydrogen Sulfide to Sulfur. L. G. Magill (assigned to Sun Oil Co.) U.S. 2,945,748 (1960) July 19.

Usual multiple-unit equipment for conversion of hydrogen sulfide to sulfur by controlled combustion and reaction of SO_2 so formed with H_2S is improved by combining the several stages in a single long insulated vessel. One-third of the H_2S is burned with sufficient oxygen to form SO_2 in a first refractory combustion space, whereupon most of the remaining H_2S reacts to form sulfur and water. Sulfur is condensed by coils and drains to a bottom pit, while residual gas at 450°-650°F passes on through a catalyst bed (bauxite, silica, alumina) where much of the remaining gases react. Spray cooling condenses the sulfur in a second condensing zone, and gases pass to a second combustion zone where additional H_2S and air are injected. Combustion reheats the gases and a second catalyst bed completes the reaction. The sulfur condenses in a third cooling zone, and waste gases are freed of sulfur in a packed tower and passed out to a stack. Sulfur drains

to the pit from the condensing zones and is pumped as a coolant to the coils and sprays.

Gas Purification Process. H. S. Bloch (assigned to Universal Oil Products Co.) U.S. 2,946,652 (1960) July 26.

Gas stream containing hydrogen sulfide is purified by putting it into contact with an organic amine dissolved in an anhydrous, hydrophilic glycol compound mixed with hydrocarbon. The purified gas is separated. The rich absorbent is regenerated by distilling the acidic gases, water and hydrocarbon (benzene, toluene) containing some amine and glycol. The latter is returned to the still bottoms (chiefly amine and glycol) and recycled to the gas scrubber as an anhydrous lean absorbent.

The Sulphur Cycle in the Gas Industry. B. E. Purkiss. *Gas J. 303,* 159 (1960) Aug. 3 (3 pp.)

Sulfur-oxidizing bacteria, responsible for a part of the sulfur cycle, catalyze the formation of sulfuric acid from hydrogen sulfide, sulfur or thiosulfate. Methods which have been used to prevent hydrogen sulfide contamination in water-sealed holders fall into four groups: 1) oxidation; 2) precipitation; 3) starvation; and 4) use of bactericides.

5. NATURAL GAS TRANSMISSION

Communications

Kansas-Nebraska Expands Its Microwave System. A. J. Sigel. *Gas 36,* 120 (1960) Aug. (5 pp.)

Kansas-Nebraska Natural Gas Co. has expanded its microwave system twice since the initial installation three years ago. Two more major expansions are planned. This growth indicates the acceptance of this mode of communications as the major method of providing a general communication service for production, transmission and distribution activities. The microwave network presently consists of two separate systems, which will probably be joined by the next expansion. A total of 21 subcarrier channels are multiplexed onto the larger system.

Maintenance: Key to Dependable Radio System. *Gas Age 126,* 40 (1960) Aug. 18 (2 pp.)

Central Electric & Gas Co. (headquarters, Lincoln, Neb.) has a two-way radio system covering its gas distribution and servicing operation in Nebraska and South Dakota. With full recognition of the importance of proper maintenance, the company has found a contract the best solution.

Metering

A Computer for Automatic Gas Flow Compensations. F. P. Simmons. *Gas 36,* 93 (1960) Sept. (11 pp.)

Errors of measurement of orifice meter coefficients and use of correction factors are discussed. The application of the Link Electron Time Division Multiplier in introducing the nine correction factors into the integration of flow is shown for single- and multi-run meters.

Pipeline Construction

Bids for Big Gas System Going Out Soon. *Oil Gas J. 58,* 47 (1960) Aug. 29.

Pipeline construction will get a healthy shot in the arm this fall when work begins on the 1404-mile gas system which will be built from the gas fields of western Alberta to San Francisco. Pacific Gas and Electric Co., chief sponsor of the system, is expected to get out bids on its portion of the line any day. The system—all but 172 miles is 36-in. pipe—will move 415 MMCF/day of gas to PG & E. The big San Francisco utility will pay 38.7 cents/MCF for the gas at the Canadian border.

Transwestern Goes All-Out for Automation. F. H. Love. *Pipeline Eng. 32,* D-20 (1960) Sept. (16 pp.)

In building the major 1960 U.S. pipeline system, Transwestern Pipeline Co. has gone all out for automation. Many new concepts are found throughout the system: automatic metering stations; automatic engine-driven centrifugal compressor stations, the first pipeline to use centrifugal compressors exclusively on the main line, the first to use X-56 grade pipe for its entire main line, as well as many other innovations. Comprehensive article discusses these features.

Pipeline Systems

Transporting Fuels by Pipelines. R. B. Toombs. *Gas World 152,* 168 (1960) July 30 (3 pp.) (Abstracted from a paper presented at the World Power Conference, Sectional Conference, Madrid.)

Large reserves of petroleum and natural gas have been discovered in Western Canada, but these resources are far removed from major markets; thus, long distance pipeline systems have been planned and constructed. An impressive beginning has been made in the application of automatic control and the initial engineering problems of design, construction and operation of oil and gas pipelines on an economic basis have been met, but further challenges await the pipeline industry in reaching more distant and competitive markets.

Telemetering

Instrumentation, Controls and Automation. Part 1. Telemetering. M. T. Nigh. *Pipeline Eng. 32,* D-42 (1960) Sept. (4 pp.)

Articles deal with concepts—different means of visualization of the principles involved in remote control, supervisory control, or supervisory indications and telemetering. First article covers simple control loop, tone control loop, tone space on voice channel and tone space on speech plus physical channel.

Supervisory Control of Pipeline. E. B. Stephenson. *Oil Gas J. 58,* 77 (1960) Aug. 22 (4 pp.)

First industrial supervisory control and telemetering system to use solid-state components throughout is operating on the Cherokee Pipe Line Co. Products System. Supervisory control was installed to permit remote control of the eight pump stations and two remote delivery terminals. Reliability of system and life of electronic

components have been satisfactory and in many respects have exceeded expectations.

Welding

Control of Manual Weldings on the Major Gas Pipelines for Natural Gas in France. P. Ruault. (Assoc. Tech. de l'Ind. du Gaz en France, 1960 Congress; 16 pp. French text.)

Discovery of a major source of natural gas in France has led to pipeline development, which, in turn, has led to problems of maintenance and economics. Moreover, the problem of safety in populated regions had to be considered. Paper deals with the control of manual welding in the fields.

6. GAS AND LPG STORAGE

Liquefaction

A Look at Ethane Liquefaction. I. Deutsch. *Gas 36,* 53 (1960) Sept. (2 pp.)

Liquefaction of ethane should be studied as a compromise between methane and propane. The physical characteristics of ethane as compared to methane indicate that ethane might be more economical to liquefy from both the capital investment cost and operating cost point of view. The condensation characteristics of ethane-air would permit much higher distribution pressures than propane-air. Extensive research might develop an economical method of converting methane to ethane, but ethane extraction equipment is commercially available now.

Methane

Cryogenics Moves in on Methane. *Chem. Eng. 67,* 98 (1960) Sept. 5 (4 pp.)

Recent advances in low-temperature technology have given fractional distillation an edge in the eternal unit operations triangle: distillation-absorption-adsorption. By distilling natural gas at −205°F, one company gets a stream of process methane having less than 100 ppm impurities—much beyond purity levels commercially attainable via absorption and adsorption. Article describes installation.

Methane Liquefaction

Sea Transport of Liquid Methane. L. J. Clark. *Gas World 152,* 290 (1960) Aug. 27 (9 pp.); **Close-up of the Methane Pioneer.** *Gas J. 303,* 262 (1960) Aug. 24 (2 pp.)

Possibilities of ocean transport of liquid methane have been put to the test in the conversion and operation of the "Methane Pioneer." This large-scale test has involved the liquefaction and carriage of 2000 tons of liquid natural gas in the converted vessel from Louisiana to the Thames. The cargo has been delivered to land storage and regasification equipment and is being used to augment London's gas supply. Experiences have added confidence to the possibilities of technical and economic success in the building and operation of large-scale liquid gas tankers.

Storage

Receipt and Storage of Liquefied Gases. C. C. Anderson (assigned to Phillips Petroleum Co.) U. S. 2,944,406 (1960) July 12.

Easily liquefied, normally gaseous fluids (liquid petroleum gases, ammonia) are stored by an improved method, which comprises a two-zone system. The first or receiving zone receives an entire shipment of the liquid by reducing shipment pressure through an expansion valve to a pressure equal to the fluid's vapor pressure at ambient temperature. The pressure is maintained by passing the top vapor through a compressor, a condenser, and expander recycle. Liquid is then transferred from the receiver to a storage tank through a similar expansion, which refrigerates the gas to near its boiling point and about 1 atm pressure. Similar vapor recycling and refrigeration is used on this second tank, but heavy, high-pressure construction is not required.

Underground Storage

Aquifers for Underground Natural Gas Storage. J. A. Kornfeld. *Am. Gas J. 187,* 21 (1960) Aug. (6 pp.)

Individual well behavior is discussed with correlations of bottom-hole conditions observed in the case of an ordinary tubed well with that of a gravel wall well. (Production and operating characteristics of these two types of wells are shown.)

Butane Goes Underground in Shell's 500,000-Barrel Rock Cavern. *Petrol. Week 11,* 34 (1960) Aug. 26 (2 pp.)

Shell Oil Co. has started pumping butane into what it calls the world's largest man-made storage cavern. Started in August 1959, and completed ten months later, the unit is built in dense limestone adjacent to the company's Wood River (Ill.) refinery, and holds 500,000 bbl of product.

California Claims Nation's Largest Gas Storage Field. *Am. Gas J. 187,* 28 (1960) Aug.

Title to the nation's largest gas storage field shifts from Illinois to California this November when Pacific Gas and Electric Company puts into operation its McDonald Island storage field, estimated to have a reservoir capacity of 178,500,000 MCF. When complete in late 1961, the field will have a working storage capacity of 30,000,000 MCF of gas and daily deliverability of 400,000 MCF. A "cushion" of 54,000,000 MCF will remain in the field to maintain minimum pressure and prevent water intrusion. Initially, however, PG&E will be able to draw out approximately 75,000 MCF daily—enough for the average winter needs of some 170,000 homes.

Engineering Aspects of Underground Natural Gas Storage. J. A. Vary. *Gas Age 126,* 42 (1960) Aug. 18 (3 pp.)

Demand on and operating "dimensions" of the natural gas storage reservoir and appurtenant facilities are entirely different and far more complex than those of the

producing reservoir. Movement in a storage operation may be 5-20 times that experienced in a gas producing operation.

Sealing Method for Underground Cavities. R. L. Loofbourow. U.S. 2,947,146 (1960) Aug. 2.

Method of sealing an underground storage cavern is claimed in which movement of in-leaking water or outflowing stored fluid is prevented by a settable film of impervious sealant. The cavern, flushed free of dust and debris, is pressurized to 2-40 psig; workmen enter the cavity, test the walls and apply sealant under the maintained pressure to obtain deep penetration. Leakage at pressures greater than 40 lb is vented by "weepholes" drilled behind the wall surfaces while the sealant is being applied and allowed to "set" under pressure.

Underground Storage Reservoir for Light Hydrocarbons in Semipermeable Rock. K. O. Johnson (assigned to Esso Research and Engineering Co.) U.S. 2,947,147 (1960) Aug. 2.

System is claimed for underground storage under pressure of volatile hydrocarbon liquids, in which a cavern is formed by quarrying in proper strata, and separate shafts for gas and liquids are provided. The cavity is lined with a fluid-tight membrane of flexible plastic, rubber or coated textile material, forming a collapsible bag which fills the cavern when distended with the hydrocarbons. The bag is protected from rock abrasion by injecting water between the cavity wall and the outside of the bag. The water is held at a constant level and the floating bag is balanced and withheld from the cavern ceiling by inert gas held under pressure. Hydrocarbons are discharged through the inlet line by injecting water which collapses the liner.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Acetylene

Acetylene Transmission Systems. *Chem. Eng. 67,* 131 (1960) Sept. 5 (4 pp.)

In addition to those special techniques required by the unstable nature of acetylene, construction and operation of a safe transmission system call for the observation of design precautions that apply to handling flammable gases. Article confines itself to safety aspects of transmitting acetylene between the source of production and the point of use.

Ammonia

Synthetic Ammonia — Nation's No. 1 Petrochemical in Volume. *Oil Gas J. 58,* 158 (1960) Sept. 5 (3 pp.)

Synthetic ammonia has the distinction of being the largest-volume petrochemical being produced in the U.S. with capacity now approaching more than 5 million tons/yr. As natural gas becomes more expensive and difficult to obtain, and fuel oils and residuum become more plentiful and readily available, the partial-oxidation route for manufacturing ammonia becomes more important. Six different types of feed, for which seven different process sequences are arranged to produce a specified quantity of anhydrous ammonia, are shown in tabular form.

Carbon Monoxide

The Removal of Carbon Monoxide from Town Gases. H. D. Edwards. *Coke and Gas 22,* 331 (1960) Aug. (6 pp.)

Removal of carbon monoxide from fuel gases used to manufacture town gas by converting it at near atmospheric pressure to carbon dioxide and the equivalent volume of hydrogen by means for the water gas shift reaction is both practical and suitable. Small-scale studies of the behavior of selected commercially available chromia promoted iron oxide catalysts when these are used to catalyse the CO/CO_2 shift reaction of carburetted water gas have been conducted.

Coal Carbonization

Notes on Low-Temperature Carbonization. C. Padovani. *Rivista Dei Combustibili 14,* 437 (1960) June (15 pp. Italian text.)

Review of main technical and economic features which characterize the so-called low-temperature carbonization. Special consideration is given to the selectivity of the process, which makes necessary to study, for each case and for each coal-type, the different aspects and the possible solutions of the problem by focusing attention on the yield and on the quality both of the solid residue and of the coal tars.

Coal Gasification

Coal Gasification—Sumitomo Process. T. Taniyama and Y. Karato. *Chem. Eng. Progress 56,* 66 (1960) Aug. (5 pp.)

New slag-bath process is used in gasification of entrained powdered coal and iron oxide mixtures by the Sumitomo Chemical Co. (Japan). Oxidation or reduction of FeO by generated gases is achieved by adjusting the steam addition to maintain the water gas conversion reaction in a state of equilibrium. Thus, ratios of CO_2/CO and H_2O/H_2, when made larger than their equilibrium constants, prevent formation of iron and keep FeO acting as a flux for silica. Flow sheets and ratio-composition curves are given. Sample gasification results are explained from data of a 50 ton/day prototype plant.

Summary of Report on Coal Derivatives: Lurgi Plant Offers Best Prospects. *Gas Times 94,* 19 (1960) Aug. (3 pp.); **Wilson Report on Coal Derivatives.** *Gas World 152,* 258 (1960) Aug. 20 (4 pp.); **Oil from Coal "Not a Commercial Proposition."** *Chem. and Ind.,* 1100 (1960) Aug. 27. (From report by the members of the Committee on Coal Derivatives.)

Report is concerned with the complete gasification of coal, and it is pointed out that the future of coal carbonization must be mainly dependent on the demand for the main product, coke. Committee believes that the amount of coal carbonized is likely to remain fairly

constant: thus carbonization will remain the most important method of processing coal. Within field of inquiry, town gas offers the greatest scope for expansion, but to make this possible, new plants will have to make gas more cheaply than existing ones. It was found that the Lurgi process is the most promising method available. But gas made by this process must be enriched before it is suitable for use as town gas, and no commercial process for making rich gas direct from coal exists. Petroleum products can be used economically to enrich the lean gas made in Lurgi gasifiers, and in this way coal and oil are complementary. Further work to increase the efficiency of the Lurgi plants on British coals will be possible when the plants now under construction are completed.

Hydrogen

Generates Pure Hydrogen Right in Plant. *Chem. Eng. 67,* 54 (1960) Aug. 22 (2 pp.)

Ultrapure hydrogen users who largely depend on cylinder supply can now put a unit in one corner of their plant and produce 99.995% pure hydrogen, on demand, from dissociated ammonia. Manufacturer claims unit is first small-volume generator which can deliver high-purity hydrogen at a price competitive with the electrolytic product. First installed unit is pegged to produce 4 MMSCF/yr.

Hydrogenation

Hydrogenation and Dehydrogenation. J. T. Bradbury, W. M. Keely, F. J. O'Hara and R. F. Vance. *Ind. Eng. Chem. 52,* 803 (1960) Sept. (4 pp.)

Usual number of articles pertaining to fundamental studies, oil and fat hydrogenation, and the hydrogenation of acetylenes, olefins, and aromatic hydrocarbons appeared during the past year. There was a slight decrease of literature relating to dehydrogenation, hydrogenation of carbon oxides, oxo synthesis, ammonia synthesis, hydrogenation of petroleum, coal, and related materials, and hydrogenation of organic compounds. High interest in the mechanism and kinetics of catalytic hydrogenation, as well as in the Fischer-Tropsch synthesis, continues.

Lignite

Sulfur in Lignite: Form and Transformation on Thermal Treatment. W. W. Fowkes and J. J. Hoeppner. *U.S. Bur. Mines. Rep. Invest. 5626,* 1960 (15 pp.)

It was concluded, on the basis of studies, that the first and greatest change in the form of sulfur present in natural lignite, upon heat treatment, resulted from the reduction of pyritic and sulfate sulfur or sulfide. Organically-bound sulfur originally present is less reactive, but largely disappears on strong ignition. An appreciable part of the sulfur content of natural lignite is fixed in the char as sulfide and the ash as water-soluble sulfate and will affect the summation of constituents, to a greater or lesser degree, in reporting the ultimate analysis of a lignite or char.

Nitrogen Oxides

Production, Fixation and Use of Nitrogenous Compounds. W. L. Morrison (assigned to Union Stock Yard and Transit Co.) U.S. 2,947,112 (1960) Aug. 2.

Recovery of nitrogen compounds from engine exhaust gases is claimed for this water-scrubbing process. Combustion air for the engine which pumps irrigation water is preheated by exchange with exhaust gases to above 120°F. Nitric oxide yield is increased by this preheating and by control of the engine cooling system. The exhaust mixed with additional air is scrubbed by the engine-pumped irrigation water in a spray and baffle contactor, which promotes oxidation of the nitric oxide (NO) to nitrogen dioxide (NO_2). The latter dissolves in the water to form nitric acid, which is a valuable fertilizer and is applied directly to the land during irrigation.

Oil Gas

Catalytic Oil Gasification in the Southern Gas Board. M. J. Birch and H. T. Lockwood. *Gas J. 303,* 227 (1960) Aug. 17 (9 pp.)

Southern Gas Board (England) installed its first oil gas plant at Portsmouth and began operation in 1956. It was the first self-steaming ONIA-GEGI plant of its size to operate in England. It has gasified both medium fuel oil and light distillate. The two units installed at the Southampton works began operation in 1958, and have used medium fuel oil, light distillate and refinery gas. This refinery gas was originally reformed in carburetted water gas plants, but in order to take full advantage of the maximum quantity available it was decided that the additional plants required would be ONIA-GEGI plants. Operating experience and catalyst behavior are reported.

Ore Reduction

Method of Beneficiating, Reducing and Briquetting Iron Ore. G. H. Halvorson (assigned to U. S. Steel Corp. U. S. 2,944,884 (1960) July 12.

Improved production of high iron concentrates from low iron taconites is claimed for a process in which the taconite (crushed to pass ⅛ in.) is mixed with peat char to provide 50% carbon in excess of that needed to reduce the iron. The ore-char next is charged to a retort, heated to 1900-2000°F for 18 hr, and quenched by water or cold inert gas. The carburized reduced iron particles are broken readily from silica gangue by grinding to 300 mesh, and are magnetically separated therefrom to yield a +90% iron powder which is briquetted.

Pushing Strategic-Udy to Profit Showdown. *Chem. Week 87,* 85 (1960) Aug. 13 (4 pp.)

New $1.5 million plant at Niagara Falls, N. Y., will convert unusable chromitic and lateritic ores into stainless steel. In three other plants, the Strategic-Udy smelting process is similarly nearing payoff time, offering firmest evidence yet of its widening commercial acceptance and flexibility. In this process, reducing gases are contacted with the ores and stone in the kiln. Rate of reduction is controlled by introducing carbonaceous

reducing material at several points, so that about 55% of the ores are reduced to metallic fines. This gives a mixture which pours "like water" into the electric arc furnace. Here, the remainder of the ore is reduced, while more slagging materials (dolomite stones, limestone, etc.,) are added to extract undesired alloys and metallic oxides.

Petroleum Refining

Catalytic Hydrocracking of Aliphatic Hydrocarbons. R. C. Archibald, B. S. Greensfelder, G. Holzman and D. H. Rowe. *Ind. Eng. Chem. 52,* 745 (1960) Sept. (6 pp.)

Work reported was initiated to assess scientifically the application of the hyrocracking of hydrocarbons to distillates derived from petroleum and to compare the results with those from conventional catalytic cracking, in terms of the reactions of aliphatic hydrocarbons. Results show that hydrocracking of aliphatics follows the carbonium ion mechanism of catalytic cracking, with hydrogenation superimposed. Differences in selectivity are attributable in large degree to the lower temperature used for hydrocracking.

Pyrolysis

The Formation of Aromatic Hydrocarbons at High Temperatures. Part 8. The Pyrolysis of Acetylene. G. M. Badger, G. E. Lewis and I. M. Napier. *J. Chem. Soc.* 2825 (1960) July (3 pp.)

Pyrolysis of acetylene at 700° yields a number of polycyclic aromatic hydrocarbons (including 3,4-benzopyrene) in addition to benzene and simple benzene derivatives. Twenty compounds were identified.

Rocket Fuels

Chemical Principles of Solid Propellants. E. Mishuck and L. T. Carleton. *Ind. Eng. Chem. 52,* 754 (1960) Sept. (7 pp.)

Manufacture and use of solid propellants is regulated by definite chemical principles—therochemistry, rheology, polymerization, mechanical properties, aging, and combustion. Principles are highly interdependent and all must be considered in formulating acceptable propellants.

Shock Tubes

The Decomposition of Methane in Shock Waves. V. Kevorkian, C. E. Heath and M. Boudart. *J. Phys. Chem. 64,* 964 (1960) Aug. (5 pp.)

Decomposition of methane in the temperature range 1656-1965°K was studied in a single pulse shock tube reactor. The reaction was found to follow first-order kinetics with the rate constant $k = 1.32 \times 10^{14} \exp^{93,000-/RT}\text{sec}^{-1}$. The homogeneous, high temperature reaction is not inhibited by hydrogen. A reaction mechanism involving the decomposition of methane to methylene is postulated to explain the major observations.

Shock Tube Experiments on the Pyrolysis of Ethane. G. B. Skinner and W. E. Ball. *J. Phys. Chem. 64,* 1025 (1960) Aug. (4 pp.)

Kinetics of ethane pyrolysis have been studied in the range 1057-1418°K in a single-pulse shock tube. Mixtures of methane, ethylene and hydrogen with ethane also have been studied to determine their effect on the kinetics. These results and literature data at lower temperatures have been correlated by a modified Rice-Herzfeld free-radical mechanism, which accounts well for the observed effects.

Shock Tube Experiments on the Pyrolysis of Ethylene. G. B. Skinner and E. M. Sokoloski. *J. Phys. Chem. 64,* 1028 (1960) Aug. (4 pp.)

Single-phase shock tube has been used to study the kinetics of ethylene pyrolysis in the range 1300-1800°K, where the chief products are acetylene, 1,3-butadiene and hydrogen. The reaction to form acetylene is essentially first order, and that to form butadiene is second order, with respect to ethylene partial pressure. The reaction seems to be molecular rather than free-radical in mechanism.

Synthesis Gas

Manufacture of Synthesis Gas. T. H. Whaley (assigned to Texaco Development Corp.) U.S. 2,946,670 (1960) July 26.

Solid carbonaceous fuel is gasified by first crushing and forming a water slurry, preheating to 750°F and 1200 psig in an elongated tubular heater, injecting the steam-coal-mixture into a long reaction coil with oxygen at high velocity, where the coal is gasified to carbon monoxide and hydrogen. The gas-steam mixture is then passed through a cyclone to remove ash and dust, the steam is condensed and the gas recovered.

Waste Gases

Cleaning Waste Gases from Open-Hearth Steel Processes. W. Strauss. *Chem. and Process Eng. 41,* 339 (1960) Aug. (4 pp.)

Cleaning waste gases from steelmaking, in particular the open-hearth furnace process, during oxygen blowing and the L. D. process, is one of the major problems facing the steel industry. In the paper, present processes, including electrostatic precipitation, thermal precipitation, fiber filtration, vertical separation and future developments in furnace gas cleaning are critically reviewed.

8. GAS DISTRIBUTION

Conversion

Converting Domestic Appliances to Natural Gas by Means of Visiting Workshop-Trucks. H. Sarrazin and M. Gillet. (Assoc. Tech. de l'Ind. du Gaz en France, 1960 Congress; 9 pp, French text.)

Summary of the experiences of the Gaz du Centre de Distribution Mixte de Bayonne in converting appliances from coal gas to natural gas at the home of the consumer.

Corrosion

A Contribution to the Study of the Corrosive Action of Town Gas on the Principal Metals Used in Distribution Systems According to Its Carbonic Acid Content. J. Morlet and A. Marianvalle. (Assoc. Tech. de l'Ind. du Gaz en France, 1960 Congress; 20 pp, French text.)

It has been observed that the corrosive action of town gas is independent of its CO_2 content, contrarily to what had been noted with gas consisting solely of CO_2, O_2 and N_2. This apparent anomaly could be due either to the presence in coal gas of unknown products or to the unforeseen inhibiting action of one of the constituents of the gas. The tests undertaken to verify these assumptions are described in the first part of the paper. The results obtained prove that the observed anomaly is due to the inhibiting action of the carbon oxide in the town gas and that this action subsists in the case of gases which have been rendered nontoxic by catalytic conversion and whose CO_2 contents have been lowered to 1% or 2% only.

Study of the Corrosion of the Principal Materials Use in Distribution Systems, due to the Natural Gas Containing Either Hydrogen Sulphide, or Hydrogen Sulphide and Oxygen Combined. C. Geoffray. (Assoc. Tech. de l'Ind. du Gaz en France, 1960 Congress; 16 pp, French text.)

In connection with investigations into corrosion by imperfectly purified natural gas, of the principal materials used in distribution, authors have certain data concerning the deterioration produced in the case of an aggressive type of gaseous atmosphere containing hydrogen sulfide associated or not with oxygen. It has been shown that in a dry medium the materials sustaining such action are but little vulnerable. In the presence of condensed water, on the other hand, the corrosion phenomena vary in their intensity according to the nature of the materials used and that of the impurities contained in the natural gas.

Metering

The Consumer's Meter. F. G. Craxford. *Gas J. 303,* 264 (1960) Aug. 24 (3 pp.)

Brief outline of the history and development of meters is followed by a description of recent refinements in design, and reasons for standardizing installations.

Engineering Orifice Meter Installations. G. H. Bolton, Jr. *Gas 36,* 47 (1960) Sept. (6 pp.)

Author presents formulas applicable in the selection of orifice plates for a multiple meter installation. The differential controller is adjusted on differential not flow and the opening and closing flows are separated to keep from confusing the differential controller. Question is: where and what should the separation in differential be? Formulas show the answer.

Investigation of Propeller Type Meters. The Maximum Efficiency Propeller. D. Souriau. (Assoc. Tech. de l'Ind. du Gaz en France, 1960 Congress; 9 pp, French text.)

Author believes that a progressive change in gas metering will take place for small gas flows in favor of nonvolumetric systems, as exemplified in particular by propeller-type meters. The development of this meter has been retarded because it is believed that it does not provide a means of absolute measurement. To refute this objection a newly designed meter, the maximum-efficiency-propeller-type, has been developed. This meter comprises a turbine to serve as a kinematic standard, a straight-bladed propeller acting as a motion comparator and an adjustable brake to absorb the variable excess power supplied by the turbine.

Odorization

Uniform Odorization. *Gas Age 126,* 27 (1960) Aug. 18 (4 pp.)

Three years of work by the Metropolitan Utilities District at Omaha have resulted in uniform odorization with savings on equipment, savings of time in adjustment, non pump leaks, and 95% reduction in cost of maintenance. Today company maintains a uniform odorization control throughout excessive variations of gas flow.

Peak Loads

Fluctuations in Gas Sales. Analysis of the 1958 Statistics. R. Odier and P. Pascal. (Assoc. Tech. de l'Ind, du Gaz en France, 1960 Congress; 29 pp, French text.)

Authors have made a complete statistical analysis of all data relating to gas emission figures which appear in the gas statistics. The analysis was conducted on the basis of a certain number of assumptions concerning the fluctuations which occur in the consumption of gas in one year. The fluctuations were considered on the basis of those which are temperature-dependent and those which are not. At the conclusion of their studies, the authors were able to derive numerical values to be assigned to the various quantities theoretically defined.

Is the Cost of Your Gas Requirement at a Minimum? C. M. Tenney, Jr. *Gas 36,* 64 (1960) Aug. (5 pp.)

Article claims a completely accurate mathematical solution of all economic gas balance problems regardless of their complexities. The method used is first year calculus, which basically goes through the motions of trying all possible combinations but requires only a few simple calculations to determine the minimum cost of sendout gas.

Plastics Pipe

A Pioneer User Tells of Its Experiences with Plastics Pipe. J. L. Sanders. *Gas 36,* 61 (1960) Sept. (3 pp.)

By September 30, 1959, Southwest Gas Corp. had a total of 2 million ft of plastics pipe installed, ranging in size from ½ through 2 in. Company first began using plastics pipe for services in 1953. Early in 1958, it started using it for mains. Results to date have been very satisfactory, and it is planned to continue its use on about the same scale in 1960 as in previous years. This will amount to about 425,000 ft of 2-in. and 215,000 ft of ½-in. and ¾-in. Methods and techniques used by Southwest in installing plastics pipe are discussed. The type used is high-impact, unplasticized, rigid polyvinyl chloride.

9. GAS FUEL UTILIZATION AND APPLIANCES

Absorption Cooling

A Look at Today's Absorption Refrigeration. S. E. Johnson. *ASHRAE J. 2,* 55 (1960) Sept. (5 pp.)

Absorption refrigeration machines have a present-day capacity range extending to 1000 tons in single units. The modern units incorporate a number of improvements in design compared to the first machine introduced in 1947. Separation of the chilled water cycle from the refrigerant cycle within the machine is perhaps the foremost improvement. The lithium bromide absorbent solution cycle within the machine has been improved by application of a quiet and efficient centrifugal pump to circulate absorbent solution to the absorber.

Air Pollution

Air Pollutional Aspects of Waste Disposal. Informative Report No. 1. Comm. TA-2, Waste Disposal. *J. Air Pollution Control Assoc. 10,* 297 (1960) Aug. (3 pp.)

Waste Disposal Committee has been charged with the responsibility of examining waste disposal procedures and to ferret out those practices which contribute to air pollution, while recommending for usage those practices which seem to be relatively free from air pollution. The conclusions reported have been derived from an exchange among engineers, scientists, technicians, and manufacturer's representatives from different geographical regions and are believed to embody the current thinking of most of those presently engaged in practices of waste disposal.

Atmospheric Pollution Poblems of the Public Utility Industry. Informative Report No. 1. Comm. TI-5. *J. Air Pollution Control Assoc., 10,* 292 (1960) Aug. (3 pp.)

Air pollution problems of the public utility industry are almost entirely those arising from the release of the products of combustion and from the storage and handling of fuels. Steam-electric generating stations are the principal public utility users of fuel and therefore are most concerned with air pollution. In such stations the heat from fuels burned in boiler furnaces produces steam. The thermal energy in the steam is converted to mechanical energy in turbines and in turn to electrical energy in generators driven by the turbines. Only minor amounts of fuel are used in the manufacture of artificial gas, by natural gas transmission and distribution systems and by water supply systems.

Atmospheric Pollution Problems of the Public Utility Industry. Informative Report No. 2 Control of Air Pollution and Practical Limits of Emission. Comm. TI-5. *J. Air Pollution Control Assoc. 10,* 294 (1960) Aug. (2 pp.)

What degree of air pollution control is justified? This question represents one of the most important air pollution problems facing government and industry. There is no single answer to the question; however, certain guiding principles have been evolved which have an important bearing on the problem. Report presents these principles as they are understood in the electric utility industry.

Discharge Electrodes and Electrostatic Precipitators. J. S. Lagaris. *J. Air Pollution Control Assoc. 10,* 271 (1960) Aug. (4 pp.)

Discharge electrodes are made in many shapes and of different materials depending upon the application involved. Factors which must be considered include the type of dust, operating temperature, corrosion, and ozone generation. The efficiency of a precipitator is shown to depend on the total power input and is especially sensitive to the discharge current. Laboratory and field data verify the use of barbed discharge electrodes to improve precipitator efficiency.

Dust Control and Prevention. R. J. Hamilton. *Chem. and Process Eng. 41,* 331 (1960) Aug. (6 pp.)

Until recently the problem of dust formation accompanying many industrial processes was considered disagreeable but not sufficiently serious to warrant particular attention. This attitude rapidly changed when it was clearly shown that dusts form both health and explosive hazards. The coal industry is one of the industries most concerned with dust control. Article discusses dust formation and its relation to particle size—a distinction being drawn between suppression and control of dust formation. By describing the characteristics of ventilation and air cleaning systems some indication of optimum selection of dust control plant is given.

The Estimation of Air Pollution Emissions in a Regional Air Pollution Control District. W. R. Crouse, G. D. Aase, H. C. Johnson, J. D. Coons and J. E. Yocom. *J. Air Pollution Control Assoc. 10,* 285 (1960) Aug. (6 pp.)

Paper describes the methods used by the San Francisco Bay Area Pollution Control District in estimating emissions from air pollution sources within its area of jurisdiction. Other than the emission data for the Bay Area District, little new information is presented. However, it was believed that the approach and methods used and the extensive bibliography would be of interest and use to other agencies confronted with a similar task.

Odor Determination Techniques for Air Pollution Control. C. W. Gruber, G. A. Jutze and N. A. Huey. *J. Air Pollution Control Assoc. 10,* 327 (1960) Aug. (4 pp.)

Odor strength, *per se,* can be measured organoleptically. These methods suffer from the variations in the ability to smell. Of the present organoleptic measurement devices, the syringe technique and the Nader dilution apparatus are recommended for measurement of odor strength at the source. For measurements in the affected area of ambient odors, the flask dilution technique and the scentometer are recommended. For the purpose of source detection of ambient odors and the gathering of proof of the source, triangulation by simple wind direction data is possible. The data must be gathered at the time of two different occurrences of the same odor with different wind directions.

The Oxidation of Hydrocarbons on Simple Oxide Catalysts. K. C. Stein, J. J. Feenan, G. P. Thompson, J. F. Shultz, L. J. E. Hofer, and R. B. Anderson. *J. Air Pollution Control Assoc. 10,* 275 (1960) Aug. (7 pp.)

Recently a large number of catalysts have been tested for the oxidation of various hydrocarbons at the Bureau of Mines Laboratories for the purpose of developing catalysts which may be suitable for oxidizing hydrocarbons in automobile exhaust gas. The exhaust from automobiles is known to constitute a major form of atmospheric pollution and catalytic oxidation in the muffler or exhaust manifold is a favored method of dealing with it. Present work at the Bureau is concerned with the development of suitable catalysts for the purpose. The study is being conducted in cooperation with the U. S. Public Health Service.

Burners

Infra-Red Hot. A. T. Haldeman. *Gas 36,* 68 (1960) Aug. (4 pp.)

Many specific heat applications have been worked out by one company, its distributors and customers who are continually turning to this gas infrared burner for successful solutions to all sorts of processing requirements. Here is a new, convenient way to produce and use heat that is as old as the sun. This form of gas heating has successfully proven its superiority to other heating methods for comfort heating, poultry and livestock raising, agricultural applications, drying, processing, as well as in other fields.

Carbon Dioxide

Natural Gas Recarbonates Water. *Gas 36,* 64 (1960) Sept. (2 pp.)

Description of installation and operation of recarbonation system at Meander Creek (Ohio) reservoir where natural gas is employed for recarbonation. Backbone of carbonation process are three submerged combustion burners—two of 1944 CF/hr and one of 972 CF/hr input—capable of producing 10,000 lb of carbon dioxide/day. Natural gas at 8 or 9 lb pressure is combined with air at a ratio of 1.03-1.05 to 10 in a mixer immediately before it is piped to the combustion chambers. Gas pressure is sufficient to keep the water out of the burner assembly. Carbon dioxide emerges from the chamber of each burner through eight outlets set in circular fashion. New process saves both time and manpower.

Combustion

The Seventh Symposium (International) on Combustion. D. H. Napier. *BCURA Monthly Bull. 23,* 269 (1959) June/July (24 pp.)

Complete account of the symposium covering both the papers presented and the discussions, was published during 1959. Present review gives some of the outstanding points from the papers (a list of which is included). The papers have been divided into appropriate sections.

Flame Research

Flame Stabilization on a Porous Plate. A. Q. Eschenroeder. *ARS J. 30,* 754 (1960) Aug. (5 pp.)

Position and stability of a flame in a boundary layer with uniform mixture injection from a porous flat plate parallel to a uniform air stream were determined experimentally. Propane-air flames were observed over a free stream velocity range of 10 to 42 fps and a range of mass equivalence ratios for the injected mixture from 1.09 to 4.76. Both the average and time variant distances from the leading edge to the beginning of the flame were measured at various free stream air mass fluxes, injection mass fluxes and injected mixture compositions. A correlation of nondimensional flame-holding distance with mixture composition was obtained.

Propagation of Free Flames in Laminar- and Turbulent-Flow Fields. R. E. Bolz and H. Burlage, Jr. *Nat. Aero and Space Admin. Tech. Note D-551.* Sept. 1960; (66 pp.) $1.75.

Report presents results of an extensive study of the influence of screen-induced turbulence on flame-propagation velocity. A refinement of the previously reported flame-kernel growth experimental technique was used. Data indicate flame speeds in flowing mixtures of air and natural gas which agree with measurements by other investigators using other techniques. An improved method of turbulence-free spark ignition is described.

Research on Pulverized-Fuel Flames by the International Flame Research Foundation. 1. Summary of Work Carried Out. G. G. Thurlow. *J. Inst. Fuel 33,* 366 (1960) Aug. (13 pp.); **2. Cold Aerodynamic Trials on a Fifth-Scale Model of the Ijmuiden Pulverized-Fuel Furnace.** G. Tissandier. *Ibid.,* 377 (9 pp.); **3. The First Performance Trial and First Combustion Mechanism Trial with Pulverized Coal.** E. H. Hubbard. *Ibid.,* 386 (14 pp.); **4. Microscopic Examination of Samples Taken from a Pulverized-Fuel Flame.** B. Alpern, P. Courbon, J. Plateau and G. Tissandier. *Ibid.,* 399 (6 pp.)

First paper describes Research Station at Ijmuiden, Holland, summarizes the tests conducted up to 1959, and states objectives of current program. Results of axial velocity measurements in an isothermal aerodynamic model of the Ijmuiden pulverized-fuel furnace are discussed in the second paper. An attempt to correlate these results is made. Purpose and results of the performance and combustion mechanism trial are outlined in the third paper. In the fourth paper, observations during and an evaluation of microscopic examination are given.

Heat Treating

High Temperature Carburizing. Part 1. W. H. Holcroft. *Ind. Heating 27,* 1596 (1960) Aug. (11 pp.)

Discussion of high-temperature carburizing field is broken into three sections: 1) results of high-temperature barburizing; 2) control of high-temperature carburizing; and 3) furnaces for high-temperature carburizing. Curves are given for rate of carbon penetration vs temperature in a) clean hardening nondecarburizing atmospheres (sometimes referred to as carbon restora-

tion), b) carbon nitriding atmospheres, and c) carburizing atmospheres.

Industrial Heating

Design Fundamentals for Combustion Air Blowers. R. A. Brackett. *Ind. Heating 27,* 1616 (1960) Aug. (8 pp.)

Proper design and selection of a gas booster, or turbocompressor, for combustion air on a heating application are important to the final results obtained. Consideration must be given not only to the pressure requirements for various types of burners, pipe sizes, control equipment and air capacity, but to the fundamental design of the blower equipment itself which makes all this possible.

Gas-Fired Periodic Kiln Produces Better High Temperature Refractories. J. W. Baggs. *Ind. Gas* (Amer.) *39,* 12 (1960) Aug. (2 pp.)

Zirconium Corp. of America produces oxides in a variety of shapes for use in many industries; kiln operates at 3250°F with no care. It is lined with alumina brick, has a hearth 36 by 18 in. and functions without the addition of oxygen or preheated air.

How Natural Gas Helps Manufacture Modern Electrical Appliances. A. Q. Smith, *Ind. Gas.* (Amer.) *39,* 8 (1960) Aug. (2 pp.)

Brazing, annealing, soldering and drying are operations in the production of modern coffee makers and vacuum bottles. Soldering is controlled by means of a thermocouple timer which automatically turns off the flames at 200°F. Drying is accomplished in a direct gas-fired oven which maintains a temperature of 330°F. Brazing is accomplished by means of a revolving, indexing table over which are a series of radiant gas burners to direct heat to exact spots on the heater units. Annealing is performed at 1950° F. in a continuous gas-fired, full muffle, hump-type furnace.

How Town Gas Helps in Metal Finishing. Part 1. Painting. S. Heywood. *Ind. Gas 23,* 20 (1960) Aug. (5 pp.)

Article discusses role of town gas in paint finishing work, and outlines the correct sequence of cleaning processes prior to the application of a surface coating, paint drying process, stove enamelling plant, infrared radiation and heating times.

LPG

The Complete L.P. Gas Farm. J. A. Thompson. *Butane-Propane News 22,* 34 (1960) Sept. (2 pp.)

At Stahmann Farms in Las Cruces, N. M., LPG is used in harvesting nuts, cultivating cotton, brooding geese; in hauling crops to processing plants, in building facilities and in heating employees' homes. Article briefly describes this farm.

Liquefied Petroleum Gases in the Gas Industry. T. G. Pringle. *Gas J. 303,* 269 (1960) Aug. 24 (3 pp.)

There are two main means for the utilization of liquefied petroleum gases by the gas industry: to augment an existing gasworks production or to completely supply mains gas either as a replacement for existing plant or as an original project. Author discusses applications of LPG in England.

Progress with Liquid Petroleum Gases. *Fuel Efficiency 8,* 25 (1960) Aug. (3 pp.)

Because of specialized application, utilization of LPG fits neatly into the general market for fuels without competing with gas and coal production. The LPG producers have discovered that the "new" fuel finds its own market by demand. Some areas seek butane for the cold enrichment of their town gas at peak periods, during retort maintenance and to enrich gas of low calorific standards. Although by comparison the LPG therm is expensive, the comparatively inexpensive equipment required means low capital costs and increased usage means lower-priced deliveries.

Pilot Lights

The Formation of Deposits on the Sensitive Element of Safety Systems. H. Schneck. (Assoc. Tech. de l'Ind. du Gaz en France, 1960 Congress; 40 pp, French text.)

Formation of deposits with a high carbon content on the sensitive elements of the safety devices used in appliances have plagued the French gas industry over the past few years. Paper examines the various causes of this phenomenon and discusses results of the investigations.

Space Heating

What Causes Thermostat Service? *Gas Heat and Comfort Cooling 11,* 31 (1960) Aug. (3 pp.)

Results of a survey of a large Eastern gas company in which over 10,000 service calls on central heating equipment were analyzed. It was found that 22.5% of these calls were due to thermostats. In tabular form article outlines 1) saturation of the various types of thermostats and 2) principal causes of thermostat trouble. The latter include contact problems, time set and customer education.

10. EQUIPMENT AND INSTRUMENTATION

Automation

Controlling a Thermal Cracking Furnace with a Digital Computer. J. R. Parsons, E. D. Tolin and A. J. Andrews. *Control Eng. 7,* 150 (1960) Sept. (4 pp.)

Program showed that: 1) a 10% increase in ethylene production was achieved by first using the computer for process analysis and testing to provide information on the best way to operate the furnace; and 2) an additional 6% increase in ethylene production from one furnace—but with a permanent on-line computer to maintain this increase—was obtained by using the computer to continually operate the process at maximum safe conditions.

Three Steps to Successful Process Computer Control. 1. Linking the Process to the Digital Computer. V. V. Tivy. *Chem. Processing 23,* 39 (1960) Sept. (2 pp.); **2. Closed Loop Operation.** W. S. Aiken. *Ibid.,* 40 (2 pp.); **3. Evaluating Computer Control.** R. F. Carroll. *Ibid.,* 42 (2 pp.)

Triology points out problems and offers some solutions to those whose companies are being introduced to computer control.

Computers

Control Computing. Part 1. An Introduction to Computer Types . . . Their Capabilities, Reliability, and Maintainability. G. Post. *Pipeline Eng. 32,* D-31 (1960) Aug. (5 pp.)

Article outlines overall comparisons of analog, digital and incremental digital computers and includes, in tabular form, the advantages and disadvantages of analog, general purpose-digital, and incremental-memory efficient digital computers for control purposes. By means of charts, the author summarizes price, number of pieces required, cost per piece, percentage of down time, and relative scale of analog, digital and special digital devices as a function of problem complexity. The latter term refers to number of variables and the form of their relationships.

Design Data

Design Digest Issue. *Product Eng. 31,* 1 (1960) Mid-Sept. (554 pp.)

Special issue is published annually. This year it includes the best of the engineering data specially selected from more than 14,000 papers and articles to serve as reference material in the design, research and development of engineered products. Topics include: general engineering; metals and alloys; nonmetallic materials and finishes; fabrication and production processes; power transmission; mechanical parts and design analysis; fastening and joining; motor, engines and controls; electrical and electronic components; and hydraulic and pneumatic equipment.

Heat Transfer

Nomographic-Type Slide Rule for Obtaining Spectral Blackbody Radiation Directly. C. D. Reid. *Rev. Sci. Instruments 31,* 886 (1960) Aug. (5 pp.)

Nomographic type of slide rule is described from which spectral radiant emittance can be obtained directly and from which the experimental power at which the spectral radiant emittance is changing with temperature for any value of wavelength and temperature can be read. The usual quantities available on radiation slide rules are also obtainable.

Instruments

Improved McLeod Gage. R. Gilmont. *Instruments and Control Systems 33,* 1350 (1960) Aug. (2 pp.)

Closed-end capillary of the conventional McLeod gage is difficult to keep clean. Now an open capillary can be used to measure low pressures; the gas is compressed in the capillary by a mercury surface at both ends.

Metering

Product-Pipeline Terminal Is Remotely Controlled. D. T. Durrant. *Oil Gas J. 58,* 75 (1960) Aug. 29 (3 pp.)

Turbine meter is used for local measurement, flow control, and remote telemetering of flow rate. Terminal makes heart-cut deliveries from 30,000-100,000-bbl batches. Success of installation is basis for construction of second unattended terminal.

Process Design

How to Prepare for Plant Startups in the Chemical Industries. J. E. Troyan. *Chem. Eng. 67,* 107 (1960) Sept. 5 (20 pp.)

Plant startup treatment has received only nominal treatment in the literature, so author elaborates on how overall efforts of process development, engineering, construction and production personnel must be coordinated to accomplish successful and on-time plant startups. Subject material includes: 1) organization for startup; 2) preparation of schedules; 3) recruiting and training; 4) operating manuals; 5) pre-startup activities; and 6) major phases of initial operation.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Cathodic Protection for Metallic Water Tanks. C. A. Bauer and L. C. Eddy. *Corrosion 16,* 390t (1960) Aug. (5 pp.)

Practical and theoretical considerations are detailed in connection with the cathodic protection of a large portable water tank. Topics discussed include theory of current distribution on parallel anodes, aggressiveness and resistivity of water, size and spacing of anodes, anode interference factor, and rectifier voltage and current requirements. A large number of equations used in calculating circuit resistance, current requirements, outputs, etc., are reported.

Effect of Iron, Aluminum and Cadmium Additions on the Performance of Zinc Anodes in Sea Water. L. J. Waldron and M. H. Peterson. *Corrosion 16,* 375t (1960) Aug. (5 pp.)

Standard hull-mounting zinc anodes of various chemical compositions were immersed in water at the Norfolk Reserve Fleet site and supplied current continuously to a large steel sea wall for 36 weeks. The current was monitored daily during the initial week and 3-4 times weekly thereafter. At the conclusion of the test, electrochemical efficiencies and current outputs were determined. Data presented show the performance of all anodes with graphical representation of typical specimens. Zinc anodes containing iron up to 0.006% and small additions of aluminum (to 0.5½%) and cadmium (to 0.10%) out-performed the high-purity zinc anodes (0.0014% iron).

Fundamentals of Cathodic Protection. J. W. Pierce. *Gas Age 126,* 31 (1960) Aug. 18 (8 pp.)

Essentially, a combination of an adequate coating and a protection system when needed gives as close to the ultimate in pipe protection as can be expected in today's

pipeline operations. Through proper use of coatings and cathodic protection if it is needed the corrosion costs may be replaced by coating at protection costs of between 1-2% of the original investment. In addition, there are many other tangible and intangible benefits that are particularly apparent in a utility pipe operation.

Coatings

Coating Performance in a Marine Environment Evaluated by Statistical Methods. F. E. Cook and A. S. Marthens. *Corrosion 16,* 411t (1960) Aug. (4 pp.)

Painted steel drums were tested at Kure Beach, N. C., and a comparison made of four paints (both for one and two coats) in two colors, on four different steel pretreatments. A method of evaluating the condition of paint is described and its use illustrated by the tests on the painted steel drums. Statistical analysis of the observed data provides satisfactory assurance of correct interpretation of the results. Film thickness is most important in obtaining durability. Specification TT-E-485 paint was confirmed as being suitable as a drum enamel.

New Improved Hot-Applied Tape Coating Designed for Single Thickness Application. D. Hale. *Am. Gas J. 187,* 18 (1960) Aug. (2 pp.)

Newest tape coating to be introduced is a coal tar product, designed for single thickness application, that incorporates many improvements brought about by continuing research in the protective coatings field. Tape is produced on an entirely new type of single purpose machine that was designed and constructed to convert raw materials into a finished product in one continuous operation.

Corrosion

Development of Thin Metal Film Corrosion Indicators. D. Roller and G. H. Rohrback. *Corrosion 16,* 399t (1960) Aug. (6 pp.)

Account is given of the development of visual and electrical corrosion indicators which utilize thin metal films vacuum-deposited on nonmetallic substrates. Data are presented showing the behavior of these indicators in corrosive atmospheres. Although the indicators were developed primarily to detect and mark corrosive conditions in packages and storage areas, other possible applications are described briefly. Data reported include comparative corrosion information on electrical cards and buttons in various humid atmospheres, condition of visual and resistance thin film indicators at first sign of corrosion on hardware items, and behavior of polyvinyl resistance card indicators at different sensitizations at 25°C and 60% relative humidity.

Effect of *p*H in the Range of 6.6—14.0+ on the Aerobic Corrosion Fatigue of Steel. F. J. Radd, L. H. Crowder and L. H. Wolfe. *Corrosion 16,* 415t (1960) Aug. (4 pp.)

Aerobic corrosion fatigue performance of a normalized AISI 1026 steel was determined in a 3% NaCl brine of various *p*H levels from 6.6 to the saturated caustic level (14+). A systematic behavior, believed typical for similar steels, was observed. These statistical test findings are summarized in fatigue curve form, and in addition, several special corrosion phenomena are recorded. Principal results are explicable in terms of ferrous hydroxide solubility and oxygen concentration cell behavior as the two primary variables. The oxygen concentration cell system is considered as a *p*H-sensitive discontinuity to the transformed ferrous hydroxide films. A theory is outlined to explain the principal points observed. Finally, control measure possibilities are suggested.

Soil Micro-Organisms in Relation to Corrosion and Cathodic Protection. J. O. Harris. *Corrosion Tech. 7,* 250 (1960) Aug. (4 pp.); *Corrosion 16,* 441t (1960) Sept. (8 pp.)

Complex nature of soil bacteria makes it imperative that they be considered in any problem related to soil. Article gives data obtained by Kansas State University from a research project credited in the U.S. as a new approach to corrosion. Most conclusions hitherto have been drawn from soil samples taken in undisturbed soil such as might be found along a pipeline right-of-way; this paper considers soil found in the pipeline ditch.

Plastics

Leaching Action of High Purity Water on Plastics and Other Materials. E. L. Knoedler and J. B. Goodson. *Corrosion 16,* 407t (1960) Aug. (5 pp.)

Laboratory tests were conducted to determine the leaching effects of high purity water on plastics and other materials used in building or lining of high purity water storage tanks. Specifically tested were enamels used in painting interiors of condensate storage tanks, materials used for filter tubes, plastic and metal materials of construction, and miscellaneous coatings and linings materials. Materials tested include polyethylene, epoxy resins, phenol-formaldehyde resins, cotton, cellulose acetate, glass fiber, mineral rubber with inert filler mixture, asphalt clay-cement mixture, polyvinyl over sprayed zinc and aluminum, sprayed zine and aluminum, hydraulic cement, commercially pure aluminum, and coal tar enamels.

12. ANALYTICAL METHODS AND TESTS

Carbon Dioxide

Titrimetric Determination of Combined Carbon Dioxide in Anhydrous Ammonia. A. R. Adam, R. Syputa and W. E. Stephenson. *Anal. Chem. 32,* 1319 (1960) Sept. (2 pp.)

Method of determining parts per million (ppm) of carbon dioxide in anhydrous ammonia has been developed. The carbon dioxide, combined as ammonium carbamate, is separated from the ammonia by weathering, and is determined by acidification and absorption in barium hydroxide. Analysis of known prepared samples in the range of 0-50 ppm showed a precision of ± 1.5 ppm.

Chromatography

Application of Chromatogaphy to Natural-Gas Anaysis. E. L. Erickson. *Instruments and Control Systems 33,* 1362 (1960) Aug. (4 pp.)

Chromatographs in use today employ a technique which is known as elution analysis. By this method, a sample is introduced into a continuous and constant stream of carrier gas which moves the components through a column at different speeds. This speed varies with each component because of the difference in adsorption on the surface of the packing within the column. The advantages of this method of analysis are that the column is continuously regenerated by the carrier gas and that the components can be separated one from another although they are mixed with the carrier gas.

Extractive Distillation Studies by Circular Gas Chromatography. R. S. Porter and J. F. Johnson. *Ind. Eng. Chem. 52,* 691 (1960) Aug. (4 pp.)

New concept of circular gas chromatography opens way to physiochemical studies. By this method, partitioning liquids of high volatility are easily handled. Potentials of this new technique were employed in extractive distillation studies using aniline as the solvent or partitioning liquid. Ratios of corrected gas chromatographic retention times give directly the limiting separation factors for molecular pairs over aniline. In this way, separation factors were obtained from 25° to 150°C for five hydrocarbon pairs of several types. The limiting separation factors given by chromatography are the most useful values in studying potentialities of solvents in commercial processes.

Gas Chromatography for Analyzing Copolymer Systems. *Tech. News Bull. 44,* 128 (1960) Aug. (3 pp.)

Rapid, vapor-phase chromatographic method for identifying acrylic polymers and copolymers as well as other resins has been developed by the National Bureau of Standards. With this approach, polymers can easily be characterized and as little as 0.2% copolymer can be detected. Acrylic copolymer composition can be quantitatively determined within ± 0.5%. By degrading the polymer mixtures or copolymers directly in the gas stream of the chromatograph, all the products can be carried immediately into the chromatographic column for analysis.

Gas-Solid Chromatographic Separation of Some Light Hydrocarbons. T. A. McKenna, Jr., and J. A. Idleman. *Anal. Chem. 32,* 1299 (1960) Sept. (3 pp.)

Combination column of silica gel and alumina may be used to resolve some permanent gases and light hydrocarbons through the C_4's. Analyses of hydrocarbons heavier than C_1 are feasible at elevated column temperatures, depending on the sample composition. These same solids may be liquid-modified to shorten analysis time at room temperature without loss of resolution.

Natural Gas Analysis by Column Chromatography. R. E. Phillips. *Gas 36,* 108 (1960) Sept. (4 pp.)

Application of the Burrell Kromo-Tog (Model K-2) apparatus to analysis of natural gas is described. Column packings and coatings and ionization detection are discussed.

Coal Ash

An X-Ray Study of Pulverized Fuel Ash. H. S. Simons and J. W. Jeffery. *J. Appl. Chem. 10,* 328 (1960) Aug. (9 pp.)

Pulverized fuel ash has been subjected to X-ray examination and chemical analysis and the main mineralogical and physical characteristics have been determined. It is shown that the ash is a very complex material in which the overall chemical composition varies from particle to particle. It is tentatively concluded that there is a positive correlation between pozzolanic activity and glass content. The types of combination of iron present in the ash have been determined and the effect of hydration examined.

Dust Determination

Single Tube Sedimentation Apparatus for the Measurement of Particle Size Distribution. J. Kobak and D. J. Loveridge. *J. Sci. Instruments 37,* 266 (1960) Aug. (4 pp.)

Equipment described is of the "liquid column with sediment extraction" type which enables dilute suspensions, 0.05% solids concentration by volume, to be used. Thus, the sedimenting conditions are approximate to those required for unhindered settling of the particles. The apparatus is simple in design and does not require any specialized skills in its operation; one operator can easily control two sizings. Two similar sedimentation tubes have been shown to be devoid of individual characteristics and to be capable of giving reproducible results. The results compared well with those obtained in other laboratories using different sedimentation methods.

Gas Analysis

Current Developments in Detectors and Test Kits for Air Sampling. J. B. Gisclard. *Air Conditioning, Heating and Ventilating 57,* 89 (1960) Sept. (4 pp.)

New chemical techniques and progress in the manufacture of miniature parts have made possible a new diversity of portable air samplers to serve the growing needs of ventilation and industrial hygiene engineers. Used with intelligence, these instruments are reliable and convenient. Article reviews current developments in portable packaging.

Halides

Automatic Chloride Analyzer. D. M. Coulson and L. A. Cavanagh. *Anal. Chem. 32,* 1245 (1960) Sept. (3 pp.)

Completely automatic method of combustion and titration improves the speed and accuracy of the determination of iodide, bromide or chloride in organic materials. Small samples (0.5-1 mg) can be analyzed in 10 min. The titration method uses a variable voltage and variable current coulometer connected directly to the combustion apparatus. The current is varied as needed to maintain a constant level of silver ions in the titra-

tion cell during the titration. The current multiplied by the time is integrated and recorded.

Helium

Determining Trace Impurities in Grade-A Helium. C. G. Kirkland, L. W. Brandt and W. M. Deaton. *U. S. Bur. Mines Rep. Invest. 5644,* 1960 (12 pp.)

Apparatus for determining trace impurities in Grade-A helium by mass spectrometer methods was designed and built. Grade-A is the designation for helium commercially produced by the Bureau. Its nominal purity is 99.995%. The device concentrates the impurities in the helium by freezing them out in a coil-and-trap assembly cooled by liquid helium. A known volume of helium is passed through the trap, the concentration ratio determined, and samples of the concentrated impurities are analyzed by mass spectrometer methods. The apparatus has been in service for approximately 20 months and has satisfactorily met all requirements.

Phenols

Colorimetric Determination of Phenolic Materials in Refinery Waste Waters. Removal of Sulfides by Silver Nitrate. G. E. Gordon. *Anal. Chem. 32,* 1325 (1960) Sept. (2 pp.)

Determination of phenol, by the 4-aminoantipyrine method in water samples containing sulfides, has required distillation to separate the phenol from the sulfides. The usual procedure has been that suggested by the API. Another procedure, using silver nitrate to remove sulfides, is faster and believed to be more accurate because it does not involve steps where phenol might be lost. It can be easily adapted for field use to give approximate results by the use of several standardized phenol solutions. The results show good agreement with the distillation method, but in general, are slightly higher. The method is also applicable to water used in refinery processes.

Radioactivity Applications

Atomic and Molecular Hydrogen Yields from Irradiated Acids. R. Livingston and A. J. Weinberger. *J. Chem. Phys. 33,* 499 (1960) Aug. (10 pp.)

Paramagnetic-resonance method has been used to measure the yields of atomic hydrogen from many concentrations of aqueous sulfuric, phosphoric, and perchloric acids at 77°K after irradiation with gamma rays. The yields of molecular hydrogen (and oxygen) have also been measured after similarly irradiated acids were warmed and the gases collected. The correspondence between atom and molecule yields is discussed. In sulfuric and phosphoric acids the atom and molecule yields depend upon whether the acid is a glassy or crystalline solid at the time of irradiation.

Sulphur

Automatic Coulometric Titrator. Application to the Determination of Sulfur in Petroleum by High Frequency Combustion. J. R. Glass and E. J. Moore. *Anal. Chem. 32,* 1265 (1960) Sept. (5 pp.)

Automatic coulometric titrator is employed in the high-frequency combustion technique for determining sulfur in petroleum. The sample is oxidized converting sulfur to sulfur dioxide which is immediately titrated as it is formed by electrically generated iodine. The instrument is applicable for acid-base, precipitation, and oxidation-reduction titrations.

13. BASIC SCIENCE

Absorption

Measurement of Gas Absorption from Bubbles under Shear. W. J. Timson and C. G. Dunn. *Anal. Chem. 52,* 799 (1960) Sept. (4 pp.)

Bubbles were sheared between a rotating drum and a stationary cylinder to study the individual effects of shear rate, viscosity, surface active agent, gas composition and bubble size. The mechanism of gas absorption from bubbles under shear was found to be that of unsteady state diffusion as postulated by the penetration theory. A mathematical analysis was made of the phenomenon. It shows that surface active agents decrease the gas absorption coefficient by inhibiting the circulation of bubble surfaces. The theoretically derived gas absorption coefficients for bubbles under shear were found to correlate well with the experimental data.

Adsorption

On the Energetics of Physically Adsorbed Films, with Particular Reference to the Use of Krypton for Surface Area Measurement. G. L. Gaines, Jr. and P. Cannon. *J. Phys. Chem. 64,* 997 (1960) Aug. (7 pp.)

Some simple considerations of the energetics of adsorbed films suggest that fairly complete monolayers of gases such as krypton should be formed before the onset of significant multilayer formation. Such monolayer formation should be experimentally observable by the Brunauer-Emmett-Teller method. It is noted that the experimentally observed variations in the molecular area parameters used to calculate areas may reflect differences in the adsorption energetics for different adsorbate-adsorbent systems. On the basis of these considerations, together with experimental results for krypton adsorption, it is concluded that recent criticisms of the use of krypton in the BET surface area method are not justified.

Heats of Adsorption and Adsorption Isotherms for Low Boiling Gases Adsorbed on Graphon. E. L. Pace and A. R. Siebert. *J. Phys. Chem. 64,* 961 (1960) Aug. (3 pp.)

Results of a calorimetric investigation of the equilibrium pressures and differential heats of adsorption for nitrogen, argon, neon, orthodeuterium, parahydrogen and helium (He^4) absorbed on Graphon in the neighborhood of their respective boiling points are presented.

Interaction of Condensable Gases with Cold Surfaces. G. W. Sears and J. W. Cahn. *J. Chem. Phys. 33,* 494 (1960) Aug. (6 pp.)

Deposition from a molecular beam onto a cold target

surface only occurs when the beam pressure is many orders of magnitude larger than the vapor pressure of the depositing phase at the substrate temperature. The critical beam pressure for deposition has been interpreted as a critical supersaturation for heterogeneous nucleation of a condenser phase. It is shown that the critical beam pressure is much too large to be accounted for as a critical value for nucleation if the adsorbate temperature and the substrate temperature are alike. The interpretation of critical deposition phenomena as a nucleation event must include the additional assumption that the adsorbate temperature is somewhat higher than the substrate temperature.

Compressibility

Accuracy of Two Generalized Compressibility Correlations. E. D. Hooper and J. Joffe. *J. Chem. Eng. Data 5,* 155 (1960) Apr. (4 pp.)

Numerous investigators have suggested that the accuracy of the familiar generalized compressibility correlations could be improved by another parameter in addition to reduced temperature and reduced pressure. Two of these proposed third parameters, the critical compressibility and a vapor pressure function, have been discussed by Lydersen, Greenkorn and Hougen, and by Pitzer. In these articles, compressibility charts using these parameters are shown to provide substantial accuracy improvements over two-parameter correlations. It is shown that Pitzer's acentric factor correlation predicts vapor pressure with good accuracy. The maximum absolute deviation was 6.6%, and the largest average absolute deviation for a substance only 2.2%. Average deviations for a single substance were as high as 10.7% for Lydersen's correlation and the maximum was 29%. In predicting the compressibility of saturated vapors, the correlations are comparable in accuracy.

On the Development of the Flow of a Viscous Heat-Conducting Gas in a Pipe. N. A. Slezkin. *Appl. Math. Mekh. 23,* 473 (1959) 2 (17 pp.) (From *Appl. Mech. Rev. 13,* 578 (1960) Aug.)

Paper considers development of compressible Poiseuille flow in entrance region of circular pipe. Method combines boundary-layer and Oseen approximations, thus reducing equations of motion to simultaneous linear partial form, which are solved by operational calculus.

N. Curle

Diffusion

Intermolecular Forces from Diffusion and Thermal Diffusion Measurements. S. Weissman, S. C. Saxena and E. A. Mason. *Phys. Fluids 3,* 510 (1960) July-Aug. (9 pp.)

Experimental values of the diffusion coefficient and the thermal diffusion factor for the systems He-Ar, He-CO_2 and H_2-CO_2, over a temperature range of about —78° to 325°C, are analyzed for the purpose of testing the Lennard-Jones (12-6) and the exp-6 intermolecular potentials, as well as the combination rules usually used in conjunction with these potentials. The exp-6 potential gives excellent results for He-Ar, but the 12-6 potential is not satisfactory. This system affords no opportunity to choose between the various combination rules. The 12-6 potential works fairly well for He-CO_2 and H_2CO_2. Overall the combination rules are very good, being no worse than the potentials themselves.

Equation of State

Measurement of Small Differences in the Second Virial Coefficient of Gases at Temperature Below °C. G. Thomaes and R. van Steenwinkel. *Rev. Sci. Instruments 31,* 825 (1960) Aug. (3 pp.)

Apparatus is described which allows measurements of small differences of the second virial coefficient between two gases at low temperatures (90°-300°K). Theoretical considerations show that the differences between virial coefficients of isotopic gases should be very small (about 2% that of the second virial coefficient itself for CH_4/CD_4 at 100°K), except at very low temperature. For this reason the apparatus has been designed to work in the range designated. Quantum effects in this range are relatively insignificant. The principle of the experiment consists in measuring the differences in volume expansions of the two gases when they are subjected simultaneously to the same change in pressure.

Heat Transfer

On Combined Free and Forced Convection in Channels. L. N. Tao. *J. Heat Transfer 82,* 233 (1960) Aug. (6 pp.)

Heat transfer problems of combined free and forced convection by a fully developed laminar flow in a vertical channel of constant axial wall temperature gradient with or without heat generations are approached by a new method. By introducing a complex function which is directly related to the velocity and temperature fields, the coupled momentum and energy equations are readily combinable to a Helmholtz wave equation in the complex domain. This greatly reduces the complexities of the problems.

Experimental Results of a Heat-Transfer Study from a Full-Scale Pebble-Bed Heater. R. B. Lancashire, E. A. Lezberg and J. F. Morris. NASA TN D-265, 22 pp., Mar. 1960. (From *Appl. Mech. Rev. 13,* 600 (1960) Aug.)

Data were obtained from the initial operation of a large regenerative pebble-bed heat exchanger in order to determine the heat transfer characteristics of a packed bed of spheres. The facility, designed to produce high-temperature air for hypersonic flight research, is described in detail. The heat transfer analysis and results are presented and compared with those of other investigators.

From authors' summary

Heat-Transfer and Flow-Friction Characteristics of Crossed-Rod Matrices. A. L. London, J. W. Mitchell and W. A. Sutherland. *J. Heat Transfer 82,* 199 (1960) Aug. (15 pp.)

Presentation of a continuation of the program on porous media heat transfer and flow friction behavior. All the previous results of interest to the designer on woven-

screen matrices and crossed-rod matrices of a random configuration are summarized. In addition, new design results for the regular in-line and regular staggered crossed-rod-matrix configurations are reported. Matrices of the type considered are applicable as heat transfer surface geometries for nuclear reactor fuel elements, for electrical resistance heaters and for periodic flow-type heat exchangers used for gas turbine regenerators, and some air-conditioning applications.

Heat Transfer to Freon 12 Near the Critical State in a Natural-Circulation Loop. J. P. Holman and J. H. Boggs. *J. Heat Transfer 82*, 221 (1960) Aug. (6 pp.)

Experimental investigation of heat transfer to Freon 12 in the critical region was conducted. A closed natural-circulation loop was used. Correlation of the data is presented. Separate equations are presented for reduced volumes less than one and for reduced volumes greater than one. The investigation covered a range of temperatures from 150°-400°F and of pressures from 500-950 psi.

Improved Lumped Parameter Method for Transient Heat Conduction Calculations. H. G. Elrod, Jr. *J. Heat Transfer 82*, 181 (1960) Aug. (8 pp.)

General mathematical method is presented suitable for the "lumping" of many damped linear systems when the response function and the forcing function can be related by a convolution integral. The method is illustrated by application to transient heat conduction in slabs and cylindrical rods.

Local and Average Heat Transfer and Pressure Drop for Refrigerants Evaporating in Horizontal Tubes. M. Altman, R. H. Norris and F. W. Staub. *J. Heat Transfer 82*, 189 (1960) Aug. (10 pp.)

Test facility for investigating local heat transfer and pressure drop for evaporating or condensing refrigerants is described. Empirical method of one investigator for correlating the average heat transfer coefficients of refrigerants exaporating in horizontal tubes is presented in conjunction with the data of several authors. Data on local heat transfer coefficients and pressure drop are presented for Refrigerant-22 evaporating in two 4-ft-long, 0.343-in. ID straight horizontal tubes, and are correlated by a refinement of the curve proposed by a previous investigator.

The "Multi-Point" Method for Determining the Separate Coefficients of Heat Loss of Bodies of Simplest Form. E. S. Platunov. Issledovariya v Obl. Teplovykh Izmereniy i Priborov, Leningrad, 1957, 78-82; *Ref. Zh. Mekh.* Rev. 8916 (1958) No. 8 (Russian text.) (From *Appl. Mech. Rev. 13*, 596 (1960) Aug.)

Method is suggested for determining the mean values of the coefficients of heat loss from the lateral surfaces and base of a circular cylinder of finite length as well as on the faces of a rectangular parallelepiped. The method is based on the cooling of a body of corresponding form in a liquid or gaseous medium at constant temperature in regular conditions. By measuring the temperatures at a number of points on the body during cooling it is possible to determine the mean values of the coefficients of heat loss on its faces, if the thermophysical properties of the body are known.

V. S. Petukhov
Courtesy *Referativnyni Zhurnal*

A Review of Heat Transfer Literature 1959. E. R. G. Eckert, J. P. Hartnett, T. F. Irvine, Jr. and E. M. Sparrow. *Mech. Eng. 82*, 47 (1960) Aug. (15 pp.)

Review of the literature in the field of heat transfer published during 1959 gives the impression that the explosive progress in certain areas which had occurred in previous years as a response to new engineering developments has been replaced by a normal research effort more equally distributed over the different modes of heat transfer.

Solution of Equations of a Thermal Network on a Digital Computer. A. J. Ness. *J. Solar Energy Sci. Engng. 3*, 37 (1960) Apr. (From *Appl. Mech. Rev. 13*, 596 (1960) Aug.)

Newton-Raphson iterative method of solving a system of nonlinear algebraic equations, which represent the energy balances at various nodes of a thermal network, is suggested. The application of the method to a specific problem, the limitation of the computer memory capacity and the time required to solve a system of 15 equations on an IBM-650 digital computer are briefly discussed.

R. Viskanta

Transient State Heat Transfer and Diffusion Problems. T. Tsang. *Ind. Eng. Chem. 52*, 707 (1960) Aug. (4 pp.)

Diffusion coefficient, volume heat capacity, and thermal conductivity in many transient state problems (especially for polymers) are not constant. Exact solutions of these problems are very difficult to obtain. However, they may be solved approximately using a method similar to time-dependent perturbation methods in quantum mechanics, but with certain modifications. Comparison of one example with numerical calculations indicates that the error involved in the approximation is smaller than expected. The perturbation scheme has certain advantages over other methods. For example, when the dimensionless time variable is fairly large, all terms except the first one or two may be neglected without introducing any appreciable error, and the solution will be in a simple analytical form.

Unsteady Turbulent Heat Transfer in Tubes. E. M. Sparrow and R. Siegel. *J. Heat Transfer 82*, 170 (1960) Aug. (11 pp.)

Analysis is made of the unsteady turbulent heat transfer in a circular tube whose wall temperature varies arbitrarily with time. The flow is steady and fully developed. The formulation permits the heat transfer coefficient to vary with time and position in accordance with the energy conservation principle. This is in contrast to previous transient analyses where it has been standard to use steady-state, fully developed coefficients.

Hydrocarbons

Compressed Hydrocarbon Gases as a Solvent. T. P. Zhuze. *Petrol. 23*, 298 (1960) Aug. (3 pp.)

Compressed hydrocarbon gases are a new type of efficient solvents first suggested for use in various technological processes. The significant advantages of these gases are: their cheapness, the possibility of controlling their solvent power by varying the degree of compression, the selective properties and the ease of regeneration. Article includes examples of the technological application of such compressed gases as solvents.

Sparking Potential and Molecular Structure of Unsaturated Hydrocarbon Gases. R. W. Crowe and J. C. Devins. *J. Chem. Phys. 33,* 413 (1960) Aug. (5 pp.)

Authors discuss the results of an investigation of electric breakdown in unsaturated hydrocarbon gases. It was found that, for a series of olefin gases, the cross section associated with the carbon-carbon double bond is greater than three times that of the carbon-hydrogen bond, while that of the carbon-carbon single bond is essentially zero as it was in the alkane series.

Kinetics

Kinetics of the Vapor-Phase Oxidation of Naphthalene over a Vanadium Catalyst. K. A. Shelstad, J. Downie and W. F. Graydon. *Can. J. Chem. Eng. 38,* 102 (1960) Aug. (6 pp.)

Rates of oxidation of naphthalene were measured for the temperature range 300°-335°C, using a thin layer of vanadium oxide-potassium sulfate-silica catalyst in a flow reactor. The amounts of naphthalene converted were determined by analyzing the products for 1,4-naphthoquinone, 1,2-naphthoquinone and phthalic anhydride. Negligible amounts of products of complete combustion were formed. The reaction rate data obtained at low conversions of naphthalene were correlated.

Mass Transfer

Heat-Mass Exchange in a Granular Layer. M. E. Aerov, N. I. Nikitina, S. S. Trainina and I. V. Gusev. *Soviet Phys.-Tech. Phys. 4,* 837 (1960) Jan. (4 pp. Russian text); (Trans. of *Zh. Tekh. Fiz., USSR 29,* 942-27, July 1595 by Amer. Inst. Phys.) (From *Appl. Mech. Rev. 13,* 600 (1960) Aug.)

Local coefficients of mass exchange in a layer of balls for Reynolds number $Re = 40$, 300 and 3000 were measured.

From authors' summary

Review Mass Transfer Concepts. J. Coates and B. S. Pressburg. *Chem. Eng. 67,* 135 (1950) Sept. 5 (6 pp.)

Mass transfer is characterized by the motion of matter through phases under the influence of intensive forces other than strictly mechanical. One objective of article is to point out what these forces are, how they are related to the rate of mass transfer and to show the logical scheme for selection of a potential difference that is useful in the calculation of mass transfer processes.

Phase Equilibria

Application of Ehrenfest Equations to Liquid-Vapor and Liquid-Solid Mixtures of He^4. O. V. Lounasmaa. *J. Chem. Phys. 33,* 443 (1960) Aug. (3 pp.)

Ehrenfest equations for the constant-volume phase transitions from the mixed liquid-vapor or liquid-solid system to pure liquid or vapor have been derived and applied in the case of He^4. Such processes serve as a model of second-order phase transitions. The reasonably good agreement found indicates that these equations may be used to check experimental data at the boundaries of two-phase regions and to determine unknown quantities entering into them.

Phase Behavior from Enthalpy Measurements. Benzene-Ethyl Alcohol and *n*-Pentane-Ethyl Alcohol Systems. P. G. McCracken, T. S. Storvich and J. M. Smith. *J. Chem. Eng. Data 5,* 130 (1960) Apr. (4 pp.)

The systems benzene-ethyl alcohol and *n*-pentane-ethyl alcohol have been investigated in a flow calorimeter from 250°-500°F at pressures from 50-1700 psia. The phase behavior of these systems and that of the benzene-methanol system previously studied are reported.

Propane

The Gaseous Products from the Oxidation of Propane at 318°C. J. H. Knox. *Trans. Faraday Soc. 56,* 1225 (1960) Aug. (10 pp.)

Gaseous products of the oxidation of propane at 318°C were determined by gas chromatography with particular attention to the relative yields in the early stages. The initial conversion of propane is 75% to propylene, 5% to ethylene and 10-20% to carbon monoxide. It is concluded that oxidation initially occurs by an HO_2 radical chain. Propylene yield in oxygen-rich mixtures reaches a maximum which is independent of oxygen pressure and nearly independent of added propylene pressure. It is concluded that an equilibrium is reached and that a change of mechanism occurs, the HO_2 radical chain giving way to a more complex multiradical reaction in the later stages.

Refrigerants

The Heat Capacity of Lithium Chloride from 15 to 325 Degrees Kelvin D. A. Shirley. *J. Am. Chem. Soc. 82,* 3841 (1960) Aug. (3 pp.)

Heat capacity of lithium chloride has been measured in the temperature range 15-325°K. The data are analyzed in terms of an optical branch model and found to agree qualitatively but not quantitatively with this model. A relationship derived from this model between heat capacity and elastic constants is found to be obeyed roughly by several alkali halides. For LiC1, $S_{298.15}$ is —14.7 ± 0.02 gibbs/mole.

Thermal Conductivity

Hot Wire Method for Rapid Determination of Thermal Conductivity. W. E. Haupin. *Bull. Amer. Ceram. Soc. 39,* 139 (1960) Mar. (3 pp.) (From *Appl. Mech. Rev. 13,* 595 (1960) Aug.)

Thermal conductivity can be determined with engineering accuracy by inserting into the specimen a line heat source consisting of a butt-welded thermocouple heated by alternating current. Thermal conductivity is calcu-

lated from the rate of temperature rise of the thermocouple. An electrical network is described which permits the reading of a fraction of a millivolt thermal emf in the presence of several volts of alternating current. The method has the advantage of being fast and simple to run, and it does not require complicated equipment.

From author's summary

Applied Hydrocarbon Themodynamics. Part 20. P-T-C K-Charts for Vapor-Liquid Equilibria in Hydrocarbon Systems. W. C. Edmister. *Petrol. Refiner 39,* 113 (1960) Aug. (8 pp.)

New P-T-C K-charts for 16 hydrocarbons, were prepared from generalized correlations by the use of critical temperature and pressure and the normal boiling point of each hydrocarbon. The values are tabulated along with the constants for a simplified vapor pressure equation.

Isentropic Processes Involving Wet Vapors. E. L. Knuth, *Ind. Eng. Chem. 52,* 688 (1960) Aug.

Reversible adiabatic processes involving wet vapors are examined for the special case in which thermodynamic effects of surface tensions are negligible; i.e., the case in which the radii of curvatures of the liquid surfaces are relatively large. Exact expressions are developed relating the final vapor quality, the *pdv* work effects, and —for flow systems—the velocity changes with the initial state and with the final temperature—or, alternatively, the final pressure—of the working substance.

Viscosity

An Absolute Determination of the Viscosity of Eleven Gases over a Wide Range of Pressures. J. Kestin and W. Leidenfrost. *Physica 25,* 1033 (1959) Nov. (30 pp.) (From *Appl. Mech. Rev. 13,* 509 (1960) July (2 pp.))

Measurements described were based on a new theory of the oscillating-disk viscometer which includes the effect of the finite radius as well as that of its cylindrical circumference. Experiments conducted verify the theory to within 0.15% when no correction for the paddle effect of the mirror is applied. The final measurements performed at 20°C for air, argon, carbon dioxide, deuterium, helium, hydrogen, krypton, neon, nitrogen, oxygen and water vapor, and, in addition, at 25°C for air, argon, nitrogen, oxygen and xenon are believed to be accurate, on an absolute basis, to 0.05% and precise to 0.01-0.07%, depending on the gas.

From authors' summary

Experimental Determination of the Specific Volumes of Water up to 1200 kg/cm² Pressures. M. P. Vukalovich, V. M. Zubarev, A. A. Aleksandrov and I. I. Kalinin. *Teploenergetika 6,* 510 (1960) No. 10 (4 pp. Russian text.) (From *Appl. Mech. Rev. 13,* 510 (1960) July.)

Experimental data are presented on the specific volumes of water up to pressures of 1200 kg/cm² and 300°C and these data are compared with the results of other investigations.

From authors' summary

Viscosity of Steam at Atmospheric Pressure. A. S. Shifrin. *Teploenergetika 6,* 22 (1959) No. 9 (6 pp. Russian text.) (From *Appl. Mech. Rev. 13,* 510 (1960) July.)

Results are explained of an experimental investigation of the viscosity of steam at temperatures from 149-866°C at atmospheric pressure. A two-capillary method, underlying the investigation, is described. A comparison is made with results of other investigations and equations are proposed which will describe the temperature dependence of the viscosity of steam.

From author's summary

Viscosity of Polar Vapor Mixtures. R. C. Reid and L. I. Belenyessy. *J. Chem. Eng. Data 5,* 150 (1960) Apr. (2 pp).

Viscosity of the vapors of many pure organic compounds and simple binary mixtures has been measured and reported in the literature. Among these, however, there have been few studies to determine the viscosity of binary mixtures of so-called polar molecules. The experimental values for the viscosity of mixtures of superheated aliphatic alcohol vapors are reported. Viscosities were determined at constant temperature and at pressures near atmospheric by measuring the pressure drop occurring upon flowing the alcohol mixture through a capillary tube.

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Institute of Fuel, Journal of (British)
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Instrumentation
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